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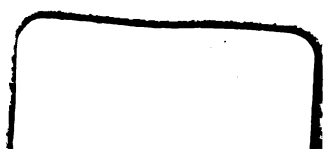
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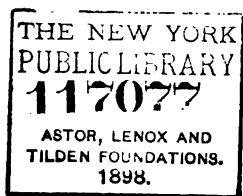
REPORT AND TRANSACTIONS
OF THE
DEVONSHIRE ASSOCIATION

FOR
THE ADVANCEMENT OF SCIENCE, LITERATURE,
AND ART.

[DARTMOUTH, JULY, 1869.]

VOL. III.
—

PLYMOUTH:
W. BRENDON & SON, 26, GEORGE STREET.
1869.



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1869-70.

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RULES.

1. THE Association shall be styled the Devonshire Association for the Advancement of Science, Literature, and Art.

2. The objects of the Association are—To give a stronger impulse and a more systematic direction to scientific enquiry in Devonshire ; and to promote the intercourse of those who cultivate Science, Literature, or Art, in different parts of the county.

3. The Association shall consist of Members, Honorary Members, and Corresponding Members.

4. Every candidate for membership, on being nominated by a Member to whom he is personally known, shall be admitted by the General Secretary, subject to the confirmation of the General Meeting of the Members.

5. Persons of eminence in Literature, Science, or Art, connected with the West of England, but not resident in Devonshire, may, at a General Meeting of the Members, be elected Honorary Members of the Association ; and persons not resident in the county, who feel an interest in the Association, may be elected Corresponding Members.

6. Every *Member* shall pay an Annual Contribution of ten shillings, or a Life Composition of five pounds.

7. Ladies only shall be admitted as Associates to an Annual Meeting, and shall pay the sum of Five Shillings each.

8. Every *Member* shall be entitled gratuitously to a lady's ticket.

9. The Association shall meet annually, at such a time and place as shall be decided on at the previous Annual Meeting.

10. A President, two or more Vice-Presidents, a General Treasurer, one or more General Secretaries, and a Council shall be elected at each Annual Meeting.

11. The President shall not be eligible for re-election.

12. Each Annual Meeting shall appoint a local Treasurer and Secretary, who, with power to add to their number any Members of the Association, shall be a local Committee, to assist in making such local arrangements as may be desirable.

13. In the intervals of the Annual Meetings, the affairs of the Association shall be managed by the Council; the General and Local Officers, and Officers elect, being *ex officio* Members.

14. The General Treasurer and Secretaries, and the Council, shall enter on their respective offices at the Meeting at which they are elected; but the President, Vice-Presidents, and Local Officers, not until the Annual Meeting next following.

15. All Members of the Council must be *Members* of the Association.

16. The Council shall have power to fill any Official vacancy which may occur in the intervals of the Annual Meetings.

17. The Annual Contributions shall be payable in advance, and shall be due in each year on the day of the Annual Meeting.

18. The Treasurer shall receive all sums of money due to the Association; he shall pay all accounts due by the Association after they shall have been examined and approved;

and he shall report to each Meeting of the Council the balance he has in hand, and the names of such Members as shall be in arrear, with the sums due respectively by each.

19. Whenever a Member shall have been three months in arrear in the payment of his Annual Contributions, the Treasurer shall apply to him for the same.

20. Whenever, at an Annual Meeting, a Member shall be two years in arrear in the payment of his Annual Contributions, the Council may, at its discretion, erase his name from the list of Members.

21. The General Secretaries shall, at least one month before each Annual Meeting, inform each *Member* by circular of the place and date of the Meeting.

22. *Members* who do not, on or before the day of the Annual Meeting, give notice, in writing or personally, to one of the General Secretaries, of their intention to withdraw from the Association, shall be regarded as Members for the ensuing year.

23. The Association shall, within three months after each Annual Meeting, publish its Transactions, including the Rules, a Financial Statement, a List of the Members, the Report of the Council, the President's Address, and such papers, in abstract or *in extenso*, read at the Annual Meeting, as shall be decided by the Council.

24. The Association shall have the right at its discretion of printing *in extenso* in its Transactions all papers read at the Annual Meeting; but the copyright of a paper read before any Meeting of the Association, and the Illustrations of the same which have been provided at his expense, shall remain the property of the Author.

25. That the Authors of Papers printed in the Transactions

shall receive twenty-five private copies free of expense, and shall be allowed to have any further number printed at their own expense. All arrangements as to such extra copies to be made by the Authors with the printer of the Association.

26. If proofs of Papers to be published in the Transactions be sent to Authors for correction, and are retained by them beyond four days for each sheet of proof, to be reckoned from the day marked thereon by the printer, but not including the time needful for transmission by post, such proofs shall be assumed to require no further correction.

27. Should the Author's corrections of the press in any paper published in the Transactions amount to a greater sum than in the proportion of twenty shillings per sheet, such excess shall be borne by the Author himself, and not by the Association.

28. Every *Member* shall receive gratuitously a copy of the Transactions.

29. The Accounts of the Association shall be audited annually, by Auditors appointed at each Annual Meeting, but who shall not be *ex officio* Members of the Council.

THE REPORT OF THE COUNCIL,

As presented at the General Meeting, at Dartmouth, July 20th, 1869.

IN presenting this their Seventh Annual Report, the Council feel that the year which has just ended must be regarded as perhaps the most pregnant with events that mark the success of the Association since 1862, when it sprang into existence, not Minerva like and strong, but a nursling requiring fostering care, and yet with the germs of giant strength inherent in it.

The Seventh Annual Meeting, held at Honiton, commenced on Tuesday, July 28th, under the Presidency of Sir J. Duke Coleridge, M.A., M.P. After the usual meeting of the Council and general meeting, upwards of a hundred members of the Association were entertained by the Mayor and Corporation at a sumptuous banquet in the spacious Assembly Rooms. In the evening, at half-past 8 o'clock, the President delivered his introductory Address.

On Wednesday, the 29th, the Association met, at 11 a.m., in the Guildhall, and commenced the reading and discussion of the following programme of papers:—

The Submerged Forest and the Pebble Ridge of Barnstaple Bay	} <i>W. Pengelly, F.R.S., etc.</i>
Notes on the Blights of Corn, with suggestions for their prevention	} <i>Rev. E. Kirwan, M.A.</i>
On the Marine and Fresh Water Sponges of Devonshire	} <i>E. Parfitt, M.B.S.</i>
On the Mount Ceniz	} <i>G. Neumann.</i>
On the Moral and Pecuniary Results of Prison Labour	} <i>Sir J. Bowring, LL.D., F.R.S.</i>
On the condition of some of the Bones found in Kent's Cavern	} <i>W. Pengelly, F.R.S., etc.</i>

On Pseudomorphous Crystals of Chloride of Sodium, and their occurrence in the Red Rocks of Devon	<i>G. Waring Ormerod, M.A., F.G.S.</i>
The Practical Application of Meteorological Observations Predicting Weather	<i>W. W. Buller.</i>
On the Calculus of Probabilities to Legal and Judicial Subjects	<i>J. Jerwood, M.A., F.G.S.</i>
On the Science of History	<i>Rev. J. E. Risk, M.A.</i>
On the Evidence of Glacial Action in South Devon	<i>E. Vivian, M.A.</i>
On the Hill Fortresses, Sling Stones, and other Antiquities of South-east Devon	<i>P. O. Hutchinson.</i>
On the Salmonids of Devonshire	<i>Dr. Scott.</i>
What is Capital?	<i>Dr. Hodgson, LL.D.</i>
On the Antiquity of the Use of the Metals, and especially of Iron, amongst the Egyptians..	<i>Basil Cooper, M.A.</i>
Sanitary Notes.—Sewer Ventilation	<i>E. Appleton, A.I.C.E.</i>
The Rainfall in Devonshire during 1866 and 1867	<i>W. Pengelly, F.R.S., etc.</i>
The Mineral Localities of Devonshire	<i>T. M. Hall, F.G.S.</i>
The Philosophy of Verbal Monopoly	<i>Dr. Bickers.</i>
The Literature of Kent's Cavern prior to the year 1859	<i>W. Pengelly, F.R.S., etc.</i>
On the Game of Chess	<i>J. Jerwood, F.G.S.</i>
Vagrancy	<i>E. Vivian, M.A.</i>
The History of the Discovery of Fossil Fish in the Devonian Rocks of Devon and Cornwall }	<i>W. Pengelly, F.R.S., etc.</i>

The great interest which the reading of the papers awakened was evinced by the large attendance, uninterruptedly continued throughout the day, and the spirited discussions which in several instances followed the reading. In the evening the Association Dinner took place, at the Dolphin Hotel; at the conclusion of which, after the loyal and other appropriate toasts had been duly honoured, the members of the Association were received with great cordiality at a *conversazione* at Tracey House, by G. Neumann, Esq. and Mrs. Neumann. Here, besides the most unbounded hospitality, a rare collection of objects, and so varied as to arrest the attention of all true lovers of art, science, and literature, however diverse might be the path they trod, was presented for the enjoyment of the assembled guests. The pleasure of the evening was enhanced by some brilliant chemical and electrical experiments, exhibited by the Rev. R. Kirwan.

On Thursday, the 30th, the reading of the residue of the

papers from the preceding day was resumed, and continued until 4 p.m., when the hospitable doors of Tracey House were again thrown open, and a choice cold collation offered to the invited guests.

In the evening, at 8 p.m., the Rev. R. Kirwan delivered a lecture, at the Manor Assembly Rooms, on "the Chemistry of the Sun," adding illustrative experiments in spectrum analysis.

On Friday, the 31st, there was an excursion to the Tumuli at Broad Down, Farway, near Honiton, when the hospitality of the inhabitants of Honiton and the neighbourhood was again liberally displayed. Three of the Barrows were examined with the most eminent success, well-preserved remains of a drinking-cup and an incense-cup being exhumed, as the excavation proceeded, in the presence of the members of the Association. These were held to be of so high importance that, at the requisition of several members, a special council meeting was convened, on August 14th, to consider the propriety of figuring the objects found, and publishing a description of them in the Transactions of the Association. At that meeting it was resolved that the Rev. R. Kirwan be requested to prepare for publication, in the Transactions of the Association, a description, with figures, of the Tumuli excavated, and of the objects found in them. The Council have the gratification to state that this resolution was most efficiently carried out, and they desire to thank the Rev. R. Kirwan for the great pains he gave himself in executing their wishes.

Besides this memoir of the examination of the Tumuli, the Council have published the President's Address, together with the papers read before the Association; also a financial statement, a list of members, and the bye-laws, and thus completed the second volume of the Transactions of the Association.

Copies of the Transactions have been forwarded to each member, and also to the following societies:—The Royal

Society, the Linneæan Society, the Geological Society, the Ethnological Society, the Royal Institution, Albemarle Street, the Assistant Secretary of the British Association, the Exeter Institution, the Plymouth Institution, the Torquay Natural History Society, the Royal Geological Society of Cornwall, the Royal Institution, Truro.

It was decided that the next meeting should be held at Dartmouth; and the following were appointed officers for that occasion:—President, G. P. Bidder, Esq., C.E.; Vice-Presidents, Sir J. D. Coleridge, M.A., M.P., W. Froude, Esq., C. Seale Hayne, Esq., H. Carew Hunt, Esq., G. F. Luttrell, Esq., Alexander Ridgway, Esq., Sir H. P. Seale, Bart., H. Studdy, Esq., Rev. J. Tracey, M.A.; Hon. Treasurer, E. Vivian, Esq., M.A., Torquay; Hon. Local Treasurer, F. Ash, Esq.; Hon. Secretary, Rev. W. Harpley, M.A., F.C.P.S., Clayhanger, Tiverton; Hon. Local Secretary, Percy Hockin, Esq.

The Council cannot close this Report without expressing their sorrow that death has again deprived the Association of a highly esteemed member—Dr. T. F. Barham, who from the formation of the Association had been one of its never-failing supporters. A brief obituary notice will be given of him in the place assigned for that purpose.

Treasurer's Report of Income and Expenditure during the Year ending July 20th, 1869.

RECEIPTS.

Balance in Treasurer's hand, July 28th, 1868	£	s.	d.
Arrears of Annual Contributions for 1868-7	13	1	2
Ditto	0	10	0
Annual Contributions for 1868-9	3	0	0
Ditto	76	0	0
Ditto	4	10	0
Ditto	0	10	0
Ditto	0	10	0
Life Compositions	30	0	0
Associates' Tickets sold at Honiton, 1868	3	10	0
Ladies' ditto	1	5	0
Interest on Deposit to June 30th, 1869	1	10	0
Sale of "Transactions," for 1862	0	12	0
Ditto	0	16	0
Ditto	1	1	0
Ditto	0	15	0
Ditto	0	18	0
Ditto	2	2	0
Ditto	0	6	6
Ditto			
Annual Contributions remaining unpaid (1867-8)	£140	6	8
Ditto	2	0	0
Ditto	4	0	0
	£6	0	0

PAYMENTS.

Brendon, for printing "Transactions" (1868)	£	s.	d.
Illustrating ditto	71	11	0
Postage and Carriage of Parcels	0	5	6
Printing Bills, Circulars, &c.	4	9	7
Printing Title Page and Index for "Transactions," vol. i.	2	4	6
Stationery	1	15	0
Swain, for Illustrating "Transactions" (1868)	0	3	6
Clarendon Press, Oxford, for Illustrating "Transactions" (1867)	15	17	0
Maddock, for printing Cards	6	0	0
Cockrem, for printing Receipt Forms	1	2	6
Advertising (1868)	0	11	0
Hon. General Secretary, for petty expenses	2	9	0
Local ditto	3	2	4
Treasurer ditto	2	3	6
Balance in Treasurer's hand, July 20th, 1869	1	3	3
	27	9	0
	£140	6	8

EDWARD VIVIAN, TREASURER.

We have compared the Books and Vouchers presented to us, and find them correct,

GEO. E. HEARDER, }
E. APPLETON, } AUDITORS.

July 20th, 1869.

STATEMENT OF THE PROPERTY OF THE ASSOCIATION,
July 20th, 1869.

								£	s.	d.
Deposit at Interest in Torquay Bank (Life Composition								50	0	0
of 10 Members)	.	.	.	.	.	.	.			
Balance in Treasurer's hand	.	.	.	.	.	.	.	27	9	0
"Transactions" in Stock 1862	..	51	at	1s. 6d.	.	.	.	3	16	6
"	"	1863	..	140	"	2s. 0d.	.	14	0	0
"	"	1864	..	163	"	3s. 0d.	.	24	9	0
"	"	1865	..	159	"	2s. 6d.	.	19	17	6
"	"	1866	..	128	"	3s. 0d.	.	19	4	0
"	"	1867	..	126	"	6s. 0d.	.	37	16	0
"	"	1868	..	93	"	6s. 6d.	.	30	4	6
								<u>£226</u>	<u>16</u>	<u>6</u>

W. HARPLEY,
Hon. Secretary.

PRESIDENT'S ADDRESS.

LADIES AND GENTLEMEN:—In opening the proceedings of your Association this year, it becomes me first to express the sense I entertain of the great honour you have done me in electing me to the Presidentship; and then I think I can adopt no better course than at once to submit my contribution towards the general fund of discussion. You will recollect that, on the last occasion of your meeting, my predecessor in this chair, Sir John Coleridge, (the present Solicitor-General,) gave an introductory discourse, replete at once with learning and eloquence, on the connexion between *Science, Literature, and Art*, the three great subjects for the advancement of which our Association was established. I cannot aspire to so high a theme: my life (as is well known to many here present) has been devoted almost exclusively to *one* of these subjects—that of *Science*, and chiefly to science in its most practical and useful applications.

Accordingly I propose to limit my field of discussion, and to fix upon one only of the many objects that enter into the domain of science—one, however, which possesses a scope and interest worthy of a far more exalted investigation. And in this design I shall but be following many examples which will be familiar to you. It is nothing new to devote exclusive attention to a small item in the wondrous system of Nature. When all its bearings are unfolded, the geologist can find a sermon in a stone, can deliver a lecture on a lump of chalk; the naturalist can write a book upon the calyx of a flower; the chemist may devote days of study to a breath of air, or a drop of water.

Now, among all the subjects that come within the scope of the engineer, there is none more interesting, and none more important, than that of RIVERS. As the arterial drains of large tracts of country; as the great sources of the water supply necessary for animal and vegetable life; as a means

of inland communication ;—in these and numberless other ways they offer occasion for all the skill he can display.

A river of any magnitude always forms an important and interesting object of general attention. Both it and the whole extent of area with which it is connected acquire a sort of personal identity, of which it is frequently difficult to find the principle. The name of the great body of water which discharges itself into the sea is generally traced backwards, by popular nomenclature, to one of the sources—usually the longest. To each branch and tributary there is given a proper name of its own ; but this becomes lost when it merges into the main river, losing (like a rich but ignoble alliance) its identity in that of the more illustrious family.

“The origin and progress of rivers, and even the features of their character, bear some resemblance (as has been well observed by Pliny) to the life of man. The river, apparently, springs from the earth ; but it has really a higher and nobler origin. Its beginnings are insignificant, and its infancy is frivolous ; it plays among the flowers of a meadow ; it waters a garden, or turns a little mill. Gathering strength in its youth, it becomes wild and impetuous. Impatient of the restraints which it still meets with in the hollows among the mountains, it is restless and fretful, quick in its turnings, and unsteady in its course. Now it is a roaring cataract, tearing up and overturning whatever opposes its progress, and it shoots headlong down from a rock ; then it becomes a sullen and gloomy pool, buried in the bottom of a glen. Recovering breath by repose, it again dashes along till, tired of uproar and mischief, it quits all that it has swept along, and leaves the opening of the valley strewed with the rejected waste. Now, forsaking its retirement, it comes abroad into the world, journeying with more prudence and discretion through cultivated fields, yielding to circumstances, and winding round what would trouble it to overwhelm or remove. It passes through populous cities and the busy haunts of man, tendering its services on every side ;—the support and ornament of the country. At last, increased by numerous alliances, and advanced in its course of existence, it becomes grave and stately in its motions, loves peace and quiet, and in majestic silence rolls on its mighty waters till it is laid to rest in the vast abyss.”*

To Rivers, then, I beg to devote your attention this even-

* This eloquent passage is taken from Professor Robison's excellent Treatise on Rivers, which has been made free use of also in other parts of this paper.

ing, and we will, if you please, consider them under three aspects.

I. Their formation and natural features; in short, what we may term their Internal Economy.

II. The great practical uses they serve, and their influence on civilization generally

III. The part they play in the formation and configuration of the earth's surface.

I. What is a river? Whence is its origin? What its end and destination? Some of you, perhaps, have traced the Thames up to its humble fountain-head in the Cotswold; the Rhine to its sources in the glaciers of the Alps; or this, its English counterpart, to the rushy swamps of Dartmoor. But science bids you look farther yet, and find their true pristine source in the *sea*. A river is, in fact, the representation and embodiment of that wonderful natural phenomenon which prevails over the whole of our planet, and which is so essential to its habitability—I mean the circulation of water to and from the great reservoir of the ocean. Indeed, no epithet could more aptly describe the whole water system of sea and river than that which the ancients applied to the fabled stream Oceanus; viz., *παλιρροος*, or “flowing back into itself.”

To explain this more fully. You know that three-fourths of the earth's surface is covered by water; and you know also that water, under ordinary atmospheric conditions, has a constant tendency to assume a gaseous form—in other words, to evaporate. If we spill a little water on a tray, we find that it will shortly disappear, and be absorbed into the atmosphere in the shape of aqueous vapour. This effect is, moreover, considerably accelerated by heat, or the motion of the air.

But now suppose a similar effect to be in operation over a water area of 145,000,000 square miles, in many parts exposed to the burning rays of a tropical sun, and swept over and agitated by constant and violent winds, and you will perhaps be able to form some notion of the mass of water which is continually exhaling from the ocean in a gaseous form. I have attempted to make a calculation of this quantity, and I estimate that it may amount to about ten hundred thousand million (or a billion) tons per diem.

To the water thus derived from the ocean may be traced the greater part of the phenomena of meteorology, comprising clouds, dew, rain, &c.; and there is good reason to believe

that many electric and magnetic phenomena have to do with the hygrometrical conditions of the atmosphere, and therefore depend also on the evaporation. But at present we have only to deal with one of these multifarious effects—*i.e.* *Rain.*

Much of the water exhaled is redeposited directly in the ocean; but when the air-currents, charged with moisture, pass over the land, they (under certain conditions) cause the aqueous vapour to be massed together in the form of clouds, and ultimately to be precipitated as rain over the surface of the ground.

So far the process has been mechanical; but we must also notice a *chemical* element. The water of the ocean is salt, in its natural state supporting only marine life; but in the process of evaporation, only the pure element of water is taken up, free from all saline ingredients; and so by this distillation in nature's vast alembic, a supply of absolutely pure *fresh water* is generated in the shape of rain. This new condition fits our world for a new and higher order of existence. It is this which affords fertility and beauty to the earth, and furnishes the sustenance necessary for the vegetable and animal life with which it teems.

We have next to consider what becomes of the rain thus distilled. Let us suppose it falling on high land, in the interior of a country. It will generally be disposed of in four ways.

(a) A portion of it will be evaporated back into the atmosphere. If the land be steep and the temperature low, this quantity will be small; but on flatter ground, and with a higher temperature, it may be a large proportion.

(b) A second part of the rainfall will be directly absorbed and utilized by vegetation; this quantity will also vary with circumstances, being but small on rocky ground, where only lichens and mosses can exist, whilst on cultivated soil the absorption will be far larger.

(c) A third portion will sink into the ground; and here again great variation is possible. In the case of hard close-grained rock, or of stiff clay, only a small proportion will enter by fissures or loose places; but into permeable strata, such as gravel and sand, or porous rocks, such as sandstone, oolitic limestone, or chalk, a large quantity will find its way, saturating the strata, and there forming large subterranean reservoirs of water, which will issue at lower levels as *springs*. To these I will return presently.

(d) After all these deductions there is still a surplus which

will *run off* the surface of the ground. In the first instance, the trickling drops will find their way into minute indentations in the surface, and will there collect into small *rills*; these as they flow on will combine to form *rivulets*; then several rivulets will unite to form *brooks* or streams; and when these find their way into a common channel they will form a *river*, which, after receiving farther accessions from other streams similarly formed, called *tributaries*, will at length discharge into the sea the waters it has collected over the drainage area through which it flows.

And now to return to that portion of the rainfall which, instead of running off the surface of the ground, is absorbed into permeable strata. This water is not permanently buried, but reappears at lower levels, wherever it can escape, in the form of springs, which, of course, go to feed the streams and rivers in their immediate neighbourhood. Many important rivers depend to a large extent on springs of this kind; and in these cases the great subterranean storage prevents sudden and violent floods, and keeps up the quantity in the dry season,—the rivers so formed having, so to speak, a larger reserve of water, and consequently being less affected by the fluctuations of the rainfall. Of this the basin of the Thames offers an interesting example. It consists in a great measure of highly porous strata; namely, the well known chalk formations to the north and the south of London, the great beds of oolitic limestone in the Cotswold region, and sand and gravel in various directions. These absorb a large quantity of the rainfall, and discharge it again in the shape of numerous and often perennial springs. Hence it is that, even in long droughts, it preserves its normal stream. For example, in the summer and autumn of 1868, when scarcely any rain fell from June to September, and the mountain streams in some parts of the country were almost dry, the Thames was not found to diminish perceptibly below its usual summer flow.

There are also, in many other places, admirable means of regulation in the form of lakes, which are merely depressions in the valleys filled up by the waters of the stream. Everybody appreciates the great beauty added by these lakes to the landscape, but few consider their great utility as equalizers and regulators of the rivers that flow through them. Their large expanse of surface enables them to serve, by varying their levels, as great store-reservoirs for the floods, which, instead of devastating the valleys, are harmlessly laid by, and are given out gradually and beneficially to the lands below.

Rivers have always been favourite subjects for investigation, both geographically and scientifically. The exploration of the rivers of Africa, as we all know, has formed for many ages a most interesting problem, which has not yet been fully solved; and many large rivers in other parts of the world are only imperfectly known. But even in more accessible countries, where the geography and topography of rivers are no longer obscure, we are still often much at a loss for information as to their scientific data. The quantities of water they bring down, the variations of this at different times, the dependence of these variations on local and meteorological conditions, the régime of the flow, the nature of the bed and the banks, and the physical changes they undergo, the quality of the waters and the causes of variation in this particular, the efficacy of the river in its duty as an arterial drain, the action of floods, and where the river is tidal, the nature of the complicated phenomena caused by the combination of the tidal and fresh waters, the formation of bars and shoals, &c. &c.,—all these things merit, and indeed require, an amount of exact investigation that they do not often receive, and which I should be glad to stimulate by every means in my power.

II. We have seen that a river is a stream of fresh water, derived in the first instance from the sea by evaporation, and flowing in a definite bed or channel back into the mother ocean.

“All mountain rivers, lost in the wide home
Of her capacious bosom, ever flow.”

We have admired, too, the wonderful mechanism by which nature sustains this process, and the many features of beauty and interest which rivers present to our observation. Our next task is to review some of the more important effects they produce, and the functions they fulfil, by their general influence on civilization, by their supplying the conditions necessary to vegetable and animal life, by constituting to a great extent the means of internal communication, and above all by furnishing our water supply.

With regard to their political influence, I would remark generally, with the late Oxford Professor of History, “that nations, like men, shape their own destiny, let Nature rough hew it as she will.” But nature *does* rough hew the destiny of nations; and the knowledge of her workings and influence is a most essential part of history. This aspect, however, is one so vast, that I should despair alike of your patience and of my own ability to bestow on it anything like an

exhaustive treatment. I must therefore content myself with indicating a few of the most salient examples. And first let us briefly review some of the effects of rivers in determining, for example, the seats of ancient monarchies—Nineveh and Babylon on the alluvial plains of the Euphrates; the Lydian Sardis on that of the Hermus; Egyptian civilization on the Nile; besides numerous less important instances. Or, again, we may in some cases trace to them a still subtler influence. The lower part of the Nile has always been so beset with shoals and sandbars as to render navigation there extremely difficult and hazardous. Owing to this, and to the abundance which its yearly inundations supplied for all their temporal wants, the Egyptians were but little drawn into the stream of ancient commerce by sea. In this respect their land offered a striking contrast to Greece, a contrast which reproduced itself in the character and pursuits of the two nations; for whilst Greece, studded as it was on the *Ægean* coast with safe harbours and anchorages, was in constant communication with the civilization of the East, ever comparing and acquiring fresh information, and thence, besides receiving directly many material and intellectual advantages, developing (what is of greater moment) a bold and inventive disposition, the case was far different in the valley of the Nile. That river, like the Euphrates, offering from year to year the same advantages to the population on its banks, and so regulating their occupation in a constant monotony, made it possible for centuries to pass over the land without any change taking place in the essential habits of its inhabitants. "Revolutions occur," it has been well said, "but no development; and, mummy-like, the civilization of Egypt stagnates, enshrouded in the valley of the Nile. They count the monotonous beats of the pendulum of time, but time contains nothing for them; they possess a chronology, but no *history*, in the full sense of the word."

Again, a glance at modern history will convince you that the influence of rivers has not diminished. Look at the Northern States of America. To what was their enormously rapid progress due, before the construction of railroads? To what but their magnificent river systems—the Hudson and the Mississippi, which enabled them to establish a cheap and comparatively rapid communication throughout the whole country. Nor can I doubt that the Amazon and the Rio de la Plata are destined to perform the same office in the future history of the great Southern Continent. On the other hand, look at the benighted and still half savage state of Central

and Southern Africa! Are we not justified in attributing this in great measure to the fact, that in that region the rivers are few, unhealthy, sluggish, and unfitted for navigation? The interior plains of Australia, too, have the prospect of remaining desolate from the absence of these great civilizing agents.

The history of Holland will furnish us with an eloquent example of the more direct effects of rivers, and also of their subtler influence, similar to that which we noticed in the case of Egypt. It was that network of rivers and canals, intersecting the length and breadth of their low-lying country, which formed the most efficient defence of the Dutch against the aggressive power of Spain in the 15th and 16th centuries, by the facility with which it enabled them to lay their land under water. At the same time a strong national and patriotic character was developed; to a great extent, as I believe, through the peculiar conditions of their local habitations. Of them, as of the Greeks, it may be said, that "the country which they so laboured to make their own by drainage and embankment, became their native land in a fuller sense than those countries where the gifts of God dropped into men's laps without any effort being necessary for their attainment."

I might also point out, if time permitted, what an important part rivers perform as the naturally constituted boundaries between different nations. I need not give examples of this. You have only to examine any ordinary map, and you will see how often the colouring, denoting a political boundary, runs along the line of a river.

But we must now turn to the more practical uses of rivers; and I will select three of these for brief remark; viz., *water supply, inland navigation, and mechanical power.*

One of the most beneficial offices that rivers serve in the great economy of creation, is in supplying fresh water where it is required. For physical reasons, which I will not now stop to explain, but which are necessary consequences of the laws of meteorology, the largest amount of rain always falls in *high mountain districts*. Every explorer of mountains is familiar with the prevalence of rain among them, and scientific records give the fact great prominence.

Now these hilly districts are just the places where, from the scantiness of cultivation and of population, water is least wanted; but here the rivers come in as beneficent agents, carrying the water down to lower regions, where it is absolutely necessary for animal and vegetable life.

The modes in which this transference of supply is made useful are many. One of the most important is *irrigation*. In some cases, as in that of the Nile (and to some small extent in European countries), the irrigation is naturally performed by the overflowing of the rivers upon the land; and as in Egypt (proper) there is comparatively no rain, the transference there of the heavy Abyssinian floods is a striking example of this office of rivers. But irrigation is more frequently applied by artificial means. The water is brought by the streams and rivers to the immediate neighbourhood, and it only requires a little skilful contrivance to turn it upon the land. In India this is done already to an enormous extent. The great rivers bring down into the vast plains of Bengal and Southern India the water which has fallen upon the Himalayas—hundreds of miles distant—and, by means of artificial works, they are made to diffuse fertility and prosperity where, without these, all would be arid desolation. The extension of the system is now exciting great attention, as one of the means of imparting to that great country a degree of prosperity for which there is ample scope. In North Italy, too, the waters flowing from the slopes of the Alps are made, by means of artificial irrigation from the rivers, to fertilize the extensive plains of Lombardy to an extent which, from the prosperity it has caused, is worthy of the greatest admiration.

In our own country, where long droughts are uncommon, irrigation is practised only to a limited extent; but even here there are few landed proprietors who do not know by experience the value of a stream passing through their grounds.

But it is not only for land and for vegetable life that the water-carrying action of rivers is applicable; they are of more importance in supplying to *animal life* this essential element of its existence. If mankind and the brute creation had no more water than could locally be caught from the skies, flat countries would be but thinly peopled, and many districts, now most flourishing, would be but deserts. It is to the water supply, brought down by rivers and streams, that the inhabitants of plains are mainly indebted for their prosperity, and, indeed, in many cases, for their very existence.

Often, particularly in agricultural districts, the supply is obtained either from the streams themselves, or by wells from the beds of their valleys, which are saturated with water. But the more extensive use made of them is in the artificial adaptations arranged to effect the *supply of water for towns*.

In early times it was a very simple matter for the inhabitants of a town to obtain water from a river or stream running close under their walls; but as the towns grew larger, and as the conveniences and luxuries of high civilization began to be more extensively introduced, it became necessary to adopt more systematic contrivances. The stream or river was always at a level lower than the buildings, and often far removed from them; hence the introduction, first, of pumping apparatus to raise the water, and then of pipes in the streets to convey it to the houses, or, in other words, of systematic *water works* for town supply.

But soon new difficulties arose. As population increased, and particularly where manufactures had been established on a large scale, it was found that the streams, which served as the natural drains of the country, became polluted by the refuse poured into them, and were rendered unfit for human consumption. Moreover, many towns grew up where no streams of pure water were at hand of sufficient volume to supply them; and this led to the necessity for seeking sources of water at a distance from the town, and for conveying it thereto by artificial means.

The ancients had at very early periods adopted this mode of supply. The famed aqueducts of ancient Rome were constructed to bring into the great city the waters of distant springs, and many other nations had followed the same system. The well known *New River*, an artificial canal or aqueduct, originally forty miles long (but now much shortened by straightening), was constructed in the 17th century to bring to London a supply of pure water from springs in Hertfordshire; and many other examples might be quoted.

The common practice now is to form reservoirs to catch the rain-water in hilly districts, and to allow the water to flow by gravitation along a channel or conduit to the town where it is required. This plan is, in fact, imitating nature's system of water supply: the reservoirs are artificial lakes, the conduit is an artificial river; but the water is conducted to a place where the topographical structure of the country did not allow it naturally to go.

The water supply of towns by this system has been extensively carried out in England. One of the largest examples is Manchester, which is supplied from reservoirs constructed on the river Etherow, draining the hills lying between Manchester and Sheffield. Another example is Glasgow, supplied by water collected in the Highlands; only in this case, instead of making an artificial reservoir, the engineer (Mr.

Bateman) has made use of the well-known natural sheet of water, Loch Katrine.

In reference to the water supply of towns, much attention has been lately directed to the *quality* of the water in rivers, on which point some interesting facts may be mentioned.

As water falls in the shape of rain, it is very pure, almost absolutely so; and in high mountain districts of hard rock, the water which flows off the land in the first instance receives very little contamination. Hence the water gathered by reservoirs in high lands is usually very pure, and this is one of the advantages attending this system of supply.

As the rain-water passes further down it gathers more foreign matter. That which sinks into the earth, and permeates porous strata, almost always dissolves matters of some kind from these rocks and earths, the principal ingredient so acquired being *carbonate of lime*, which gives to the water the peculiar quality known as *hardness*. Hardness in water is no disadvantage for drinking, it is usually considered rather the reverse, but it deteriorates the water for washing and for manufacturing purposes.

The quality, however, is affected in another way, which is not always so harmless; namely, by the foreign matters draining into the rivers at various parts of their course. Much of this consists merely of earthy particles, suspended in the water, and can be entirely removed by subsidence or by filtration. But the water may receive chemical contamination, which is generally caused by washings from cultivated land, or still more from the sewage of towns. This would be more difficult to get rid of were it not for a most beneficent natural arrangement, which provides spontaneously for the purification of the streams. This is by the *oxidation* of the matter, partly by the free oxygen present naturally in the water, and partly by access to the air. The organic compounds are very instable in their nature, and the action of oxygen breaks them up and converts them into inorganic salts, perfectly innocuous.

We have many instances where this interesting and beneficent natural chemical process is most marked. London is one. It had been represented that the inhabitants were being poisoned by the water of a river which received the drainage of 3700 square miles, and of 800,000 inhabitants; but recent investigations have shown, strange to say, that the river is actually purer a little above London than at any other point of its course.

But though nature is so good to us, we must not abuse her

beneficence ; and I hold it as an important principle of public policy, that the Government of the country ought to use its utmost power to preserve the rivers—the arteries of the very life-blood of the nation—from every species of noxious pollution.

Inland Navigation. Another great practical use of rivers is the facility they afford for *inland locomotion*.

The “silent highway” afforded by rivers has been taken advantage of from the oldest periods of history, and the communication they have afforded, not only between different parts of the country through which they pass, but with the sea, and thence with the entire coast, has been at all times one of the most obvious sources of prosperity to a nation.

A great step in advance of these natural facilities was made by the construction of canals, which brought the facilities of water communication into places where the natural rivers could not reach ; for canals not only traversed plains and flat valleys, but by engineering skill they could be made to mount hills and to serve districts at any elevation.

The water for these canals was obtained in a great measure from natural streams and springs ; and some of you will remember the reply of Brindley, the great canal engineer, who when asked (in disparagement of his system) what he supposed rivers were made for ? naively answered, “To feed canals.”

But though canals produced a vast increase of inland traffic beyond that practicable by natural rivers, they too had a limit, determined by the quantity of water they could obtain. Thirty or forty years ago this limit had been reached, and then most opportunely came the new invention—the railway ; and on the impulse given by this to the commerce of the country I need not dwell.

But I do not believe that railways will or ought entirely to supersede inland communication by water. In many places, and for many objects, of course, this system cannot compete with the rail ; but there are situations in which, for a particular kind of traffic, rivers and canals, with the benefit of steam-power upon them, may, I am convinced, be always found useful.

Mechanical Power. In describing generally what a river is, I have alluded to the enormous quantity of water evaporated from the surface of the ocean. Now it is worthy of consideration, what a gigantic amount of *power* is represented

by this evaporation. I have given the daily amount at 1,000,000,000,000 tons, and we shall be very much within the mark in assuming that this is raised on an average 2,000 feet high.

But to do this requires an expenditure of power equal to steam-engines of 90,000,000,000 horse power, to feed which the whole quantity of coal annually raised in Great Britain would barely suffice for *one hour's* consumption!

So little do we think in these calm sunny days of summer what enormous forces are at work all around us!

I have endeavoured to test these figures by some cases in which the quantities are actually known. Take the Nile for example, which, in its average state, brings down about 20,000,000 cubic feet of water per minute. If we suppose this to have descended from 3,000 feet altitude (which is much under the mark, as it comes entirely from the high mountains of Abyssinia and equatorial Africa), this will develope above 100,000,000 horse power. The area of drainage of the Nile is about $\frac{1}{100}$ of the whole earth's surface, and this amount is proportionately less than our former calculation, the deficiency being accounted for by so large a portion of the area being desert, where no rain ever falls.

Another example, the Ticino, though a much smaller river, gives a very much larger proportionate result. Its drainage area is only $\frac{1}{100000}$ of the earth's surface, and yet it brings down 645,000 cubic feet per minute. This comes in a great measure from high levels on the south slopes of the Alps; but if we assume the height here to be only 3,000 feet, we get 4,000,000 horse power for this little stream, being nine times what is due to its drainage area, according to the figures I have assumed in my first calculation.

Yet, vast beyond comprehension as is the amount of power represented by the evaporation on our globe, it forms only a very small fraction of the whole force given out by the great source of heat to our system. It is evident that our earth, if viewed from the sun as a centre, forms little more than a speck of area, catching only a little pencil of the rays of heat which the great furnace projects through space. I have calculated that

“Around this radiant sphere of central fire”

no less than 2,000,000,000 of such worlds as ours might be congregated, each one receiving an equal amount of heat from its fierce glow. Hence, if we multiply the immense figures I at first gave you by 2,000,000,000, we may come a

little nearer to the estimate of the power given out by the sun; but in so doing we shall have far outrun the capability of our finite powers of comprehension.

And should we not be still more at a loss, if we were to attempt to go farther, and to try to form some idea of the nature and operation of the source of this great action—to open, as it were, the door of the furnace, and try to make out the nature of the fuel burning within, and the mode of its combustion? Physicists are already doing much to investigate the nature of the sun's surface, and they deserve all honour for their discoveries; but I can, for my own part, see but little prospect of any satisfactory light being thrown on this most vast, most wonderful, most mysterious problem.

Now some portion of this power (although only a small fraction of the colossal whole) is rendered available for our use by the *descent* of the water again to the ocean. Wherever there is a *fall of water*—either *per saltum*, as in a cascade; or more gradually, as in every flowing stream—there mechanical power is developed. For example, the Falls of Niagara represent about 7,000,000 horse power, which, if it could be rendered available, would supersede all the steam-engines on the continent of America. The flow of the Thames, in its mean state, between Wiltshire and Teddington, has 60,000 horse power.

But it is only to a very small extent that water power is at present beneficially used; namely, by water-wheels, and other water-engines on small running streams. The fact is, that at present steam power produced by coal is so cheap and convenient as to eclipse all other sources; but the time will certainly come (though it may be long hence) when the coal can no longer be so economically raised, and, unless some unforeseen substitute should in the meantime be found, the fact of the existence, so close at hand, of such a vast reservoir of perpetually self-renewing mechanical power may be of great significance.

I cannot pass over the subject of the connection between heat and power without alluding to the favourite and oft-quoted idea of my dear old friend George Stephenson, as to the derivation from the sun of the heat-giving power of coal. It delighted his practically reasoning mind to trace the origin of coal to the vegetation of the carboniferous epoch, in which the carbon was accumulated in the vegetable fibre by the action of heat; and he would say that in this manner we are now availing ourselves of a preserved store of caloric, originally imparted by the sun's rays millions of ages ago. By this

curious but accurate reasoning, (as well as in many other ways I could name if time allowed,) we may trace the application, for our practical benefit, of this universally prevailing agent.

III. Thirdly and lastly, I have still to speak of rivers as geological agents; in other words, of the influence they exert in changing the physical features of the earth's surface, and in modifying the distribution of its materials.

Persons unfamiliar with geological questions are apt to consider the rocks and the mountains as emblems of eternal stability. A closer observation, however, will easily convince us that this is only a poetic fiction. We cannot look at a river, or a river bed, without being impressed with the idea that the whole surface of the earth is in a state of constant though gradual change, and that the rivers are the great agents by which this change is effected.

The pebble in the brook—what is it? where did it come from? where will it go to? It is a piece of some rock far away, torn from its parent crag by the action of water. Water has rolled and chafed it into its present form; water has brought it to its present position; and water will by-and-by carry it onward still further from its first home, grind it to powder, and finally disgorge it into the sea, when some tide or current will deposit it on a submarine bed, from which, myriads of ages hence, it may rise to be a rock again!

We need only go to the source of some large river—say of the Rhine or the Rhone in the glaciers of the Alps—in order to see such changes going on. The rocks in these high regions are continually under process of destruction, chiefly through the action of the weather on their precipitous sides. Stones and pieces of rock are continually falling in avalanches on the glaciers, or by landslips down into the valleys; thence, when the snows melt, to be rolled downwards by the swollen torrents. And remember that every stone we see there is so much absolutely and for ever subtracted from the rock above, and is a certain step towards its ultimate demolition.

And it is not only by these means, and in these countries, that this kind of action goes on; it proceeds in greater or less degree in all kinds of ground where water flows. Every stream, every rivulet, every rill, almost every drop, bears its part in this process of destruction. Wherever there is running water there is the element of *erosion*, slowly yet surely doing its work. Even the clear springs do their share; for

the salts they hold in solution are robbed from the rocks over which they flow.

If we take a glance over the surface of a "*river basin*" (by which term we designate the area of ground which the river drains) we find it divided into several valleys, each possessed (inhabited, I might say,) by its own particular stream. In the great majority of cases these valleys have been *formed* by the gradual eroding action of the streams that run in them. There has been much ingenious speculation among geologists and physicists as to the origin and mode of formation of valleys. Many have called in the aid of violent convulsions of the earth, cataclysms, and other extraordinary phenomena to account for them; and no doubt some parts of the earth's formation do bear the traces of some such operations at a remote period. But when we have regard to what is constantly going on under our own immediate observation, we are forced to reckon the eroding action of water as the greatest and by far the most potent cause of physical change on the earth's surface.

I have hitherto spoken of this action as only eroding—only that of carrying away matter. But what *becomes* of the matter thus carried off?

To answer this question let us revert to our mountain torrent, and trace its course downward. As we follow it we shall find that the slope of its bed gradually becomes less steep, and its current less impetuous; we shall also find a difference manifested in the aspect of the matter it brings down. It will still contain stones—large ones, probably—but they will not be so large as on the higher level: they will have been broken or worn down into smaller sizes, and there will be more of them. As we go lower the stones will be still more reduced in size and increased in number, till they become mere pebbles. Lower still they will be found mixed up with finer detritus, forming *gravel*; while last of all, in the flat ground more nearly approaching the termination of the river's course, we shall find sand, alluvial earth, mud, and silt, but all derived from the rocks and strata worn away by the stream at higher levels.

Now these various matters—stones of various sizes, gravel, alluvium, and so on—will all be deposited and dealt with in various ways by the river, at various parts of its course.

In the first place this detritus will be deposited, wherever practicable, to form the bottoms of the valleys, which are invariably, when flat, found to consist of this kind of material. This deposition, however, in the case of the smaller and higher

valleys, is not permanent, the river having a tendency, when violent, to rake it up again, and carry it still lower down. In the larger and wider valleys it may remain for long periods of time. Almost all the great valleys we know are lined with matter thus brought down at early periods, and forming comparatively permanent strata, through which the river now more peaceably threads its way.

When there is a lake in the course of a river, it is at once made use of by the stream as a favourable site for deposition. Take the Lake of Geneva, for example. The Rhone stream, entering at the upper end, brings down large quantities of detritus, which is deposited there, gradually silting it up, while the water, freed by this deposition from its impurities, flows out clear and bright at the other end. The lake, however, is every year becoming smaller and smaller, and will ultimately be filled up. There are numberless instances of filled up lakes (now flat alluvial plains) in the valleys of the Alps; and what are called *lacustrine* or fresh-water formations, so well known to geologists, have been formed in this way.

But the great mass of the matter abraded from the rocks by a river is carried down to its natural termination—the sea. At the mouth of every large river we find a huge recent formation, called the *delta*, which consists entirely of detritus, brought down by the river from the upper districts, and deposited there, where the running water first comes to rest in the body of the ocean. The deltas of the Nile, and the Mississippi, and the Sunderbunds, or great delta of the Ganges, are perhaps the best known of these formations; but they exist, more or less, at the mouths of all rivers, constantly increasing, and continually causing the formation of new land where formerly existed only deep water.

But these visible accessions to the surface of the earth represent only a small part of the continual increase. As the water of the river mixes with that of the sea, the detritus it holds is carried off by tides and currents, and deposited in large quantities under water. To this action are due the *bars* and *shoals* formed near the mouths of large rivers, and which, by their continual changes and gradual increase, are so troublesome to the navigation.

In all these cases, therefore, we see how the matter eroded from the upper lands by aqueous action, is by aqueous action deposited at lower levels, thus forming land again.

These considerations will, I think, show you what mighty agents rivers are in effecting geological and topographical

change. It is not too much to say, that if the present system of the world should endure sufficiently long, (and who can, without presumption, fix any time for its termination?) the mighty chains of the Alps, the Andes, and the Himalayas, must at last disappear under the agency of the Rivers, by which they are even now under progress of destruction.

Yet, however, destruction it is *not*. It is only transference. For as the mountains melt away and the hills disappear, we find that, by the same agency, from their ruins new tracts of land, new continents, and, ultimately, a new world shall arise.

But did I say that *water* was the cause of all this? I must correct myself; for, at the outset of what I said about rivers, I pointed to a subtler and earlier agency to which all these phenomena are due—namely, *heat*. It is the *heat* of the sun that evaporates the water from the ocean; it is the *heat* which, in some mysterious way, produces the meteorological conditions causing its deposition; and hence it is *heat* which we must regard as the ultimate physical cause of all the changes I have described.

The history of geology tells us of a great controversy that long raged as to whether fire or water was the true element of the earth's change. Modern science assigns to each a large share; but the action of water is only secondary, and the Plutonians must be admitted to be right in the main.

What heat is we are only beginning to have an idea of; recent discoveries tell us it is simply a mode of *motion*, and lead us to conjecture that it may be only one form of some still more mysterious action, which may ultimately be found to embrace all kinds of physical force, all varieties of material agency, and, perhaps, even all modifications of vital power.

But here I am entering an unknown region, and I must go no farther.

I trust that I have now succeeded in indicating to you, in some measure at least, the interest attaching to this subject, and its many and important bearings, alike on History, Social Economy, and the vast field of Science. Before, however, quitting the subject, and thanking you for your kind attention, I would take this opportunity of entering my protest against a large and influential school of modern science, whose sagacity, indeed, and breadth of view I freely admire, but the general tendency of whose teaching I cannot but regard as unhealthy and untrue.

I am the last to deny—and I have been at some pains to illustrate to you—the great influence rivers, among other natural phenomena, exert on the constitution and state of the human race. But is this all? Is Man the mere plaything of Matter? the outcome of certain physical conditions, and nothing more? In other words, Does Science forbid us to suppose a Great First Cause, working, though latent, in all Creation, and bid us find in brute matter the ultimate source of the Universe?

Such would seem to be the opinion held by many philosophers of our day. "It is all very well," you may hear them say, "to extol the beneficence of Providence in the order of Nature. It almost provokes a smile to hear you dilating on the contrivances by which rivers subserve our life and well-being. Modern Science," they will tell you, "has exploded all such day-dreams, and shows that this idea of a Providence is but mistaking cause for effect. Your rivers are but one among the infinite number of phases of the dark hidden power we call matter, by which the earth's surface undergoes incessant change, while men are but the temporary tenants of their banks. You may picture them with all glowing and gracious attributes, but you are only feeding your fancy on the reflected hues of your own mind. Rise above these human infirmities, and view Nature under the clear, cold light of Science, and you will see that she wears but an aspect of stern impassibility."

Such is the language that would be used by the materialist. I have no intention of offering a complete refutation of such metaphysical speculations, but, simply confining myself to the subject before us, I hesitate not to assert my belief, that here, as elsewhere, science requires us to recognise a first cause beyond and prior to the material phenomena we investigate.

We see how it was one and the same agency by which the sea was collected, the land and the mountains upheaved; and so the rainfall and the flow of rivers were sustained, and life was propagated, through their means—I mean heat, or the motion in matter. In rivers at least there is no room for supposing any *development*. As soon as our molten planet had fallen to a certain temperature, then the river system commenced in all its perfection, with all its powers of fertilizing the earth, and making it fit for the habitation of man. No "fortuitous concourse of atoms" can explain the law on which rivers depend. In it we reach a point beyond matter, nay, which constitutes the only condition in which matter exists, or at least is known to us. But

shall we, therefore, with Heraclitus, find in Heat the cause of the universe? or, with Zoroaster, inaugurate the worship of fire? It would be at least *as* rational as this humbling of ourselves before "eternal matter," and then ascribing to it creative power, just as if a man were to prepare a banquet and expect the dishes to create the guests.

It seems to me that this materialism is really the invasion of science on the province of religion and feeling. There is a point where knowledge ceases to be possible; but to assert therefore that nothing exists beyond, is to assert a knowledge of what we cannot know.

We are forced indeed by our minds to view everything as the effect of some agency, and therefore to assume the existence of a first cause; but know it, grasp it as an element of our knowledge, we cannot. It is beyond the range of experience, beyond the pale of science. But though science tells us of nothing beyond these ultimate and inseparable factors in all things—*heat* or motion, *matter* or the thing moved—she nevertheless refuses to invest either with the insignia of divinity, but, bowing before the altar of the God unknown to her, she steps back for religion to lift the veil.

Obituary Notice.

T. F. BARHAM, M.B., CANTAB.,

AND LICENTIATE OF THE ROYAL COLLEGE OF PHYSICIANS.

COMPILED BY THE HON. SECRETARY OF THE ASSOCIATION.

THOMAS FOSTER BARHAM was born at Henley-on-Thames on September the 10th, in the year 1794. He received his early education chiefly at private schools, and in due course proceeded to the University of Cambridge, and became a member of Queen's College. He took the degree of B.A. in 1816, being contemporary, or nearly so, with some whose names have existed as household words in that university, as Professors Whewell, Jeremie, Blunt, and King. Choosing medicine for his profession, he pursued his studies in London, in the hospitals of Guy's and St. Thomas's, and the schools connected with them. He took the degree of M.B. at Cambridge, and afterwards became a licentiate of the London College of Physicians. He settled in practice at Penzance, where he lived a good many years, and then removed to Exeter. At both these places he devoted much time and skilful care to the sick poor, but did not use very strenuous efforts to acquire a lucrative practice, which was not necessary to his maintenance, as he had sufficient means. He had married early in life, and his family, which proved a large one, was well provided for. More than twenty years before he died he returned to High-week, in the neighbourhood of Newton Abbot, and lived entirely in the country; but his advice was still eagerly sought by the poor, and as heartily and cheerfully given to them.

During this latter period he devoted much time and money to the religious instruction of the people near him, and his voice of comfort was heard and listened to with devout

attention by an interesting flock which he had gathered around him. Dr. Barham was a man unostentatiously, unmistakably, and courageously devout. No one was less disposed, for his very nature was gentlemanly and courteous, to introduce his opinions on religious matters so as to give offence to those from whom he differed. In the exercise of a free judgment, he gave as generous a construction to the opinions of others as he hoped and deserved to obtain for his own. In the various controversies in which he took a part, his views were always lucidly put forward and temperately argued; yet while it may be and is a part of all true devotion to commune with self in secret, and in public with those that have our special sympathy, there are times when valour and even heroism is wanted to confront those whose doctrines we deem detrimental or dangerous. A disinterested sincerity—sometimes associated with self-sacrifice—but transparent as the mountain stream, and ever pressing forward towards the wiser and the better, marked the whole of his career. After leaving the University of Cambridge he relinquished the Trinitarian opinions in which he had been educated as a member of the Church of England, and became a Unitarian. Whether this change of sentiments was wise or not is a question apart, but his reasons for making it were plainly and boldly set forth in a small work entitled “Unitarian Doctrine,” in which he endeavours to prove that one God, the Father, is the only proper object of worship. This little work was so well approved as a brief epitome of the Unitarian argument that it passed through several editions, the last in 1867.

He likewise published a small book called a “Help to Scriptural Worship,” containing a revised form of the services of the Church of England, with a selection of psalms and hymns, and improved renderings of texts of the New Testament. (1821.)

Another of his works was a Unitarian liturgy, under the title of “Forms of Prayer for Public Worship.” This he composed in conjunction with Mr. Acton, the minister of George’s Chapel, Exeter. It was publicly adopted by that chapel, as well as by many others whose congregations approved of it.

He likewise published a “Monthly Course of Forms of Prayer for Domestic Worship.” (1846.) These are all his own compositions, except certain occasional extracts from the prayers of Jeremy Taylor, Johnson, Jenks, &c., and they are distinguished for earnestness, simplicity, good sense, and practical usefulness.

His largest and most important work is entitled, "Philadelphia; or, the Claims of Humanity. A Plea for Social and Religious Reform." (1858.) In this book he represents his views of a Christian system of ecclesiastical and political economy, and the bearing of the principles of the gospel on the chief national and social questions of our times. This work is eminently original in its conceptions, and it contains many reformatory suggestions of high importance, though some others may be deemed visionary and impractical. He anticipated the great Church reforms which are even now pending, and the great agrarian remodifications which may follow. He pleads for peace, temperance, frugality, and utilitarianism, as opposed to luxury and extravagance. He confirms his opinions by extracts from such writers as Fenelon, Penn, Paley, Smith, and especially of authors who have compared the economies of other nations with our own. He is opposed to the laws of primogeniture, and he recommends the subdivision of large farms into small ones, and a general allotment system. Thus he would turn multitudes of persons, now existing as superfluous idlers or mischievous criminals, into agricultural or horticultural labourers, and utilize them as far as possible by the improvement of lands already partially cultivated, or at present altogether uncultivated. In short, in this respect he prefers the French agricultural system to that which prevails in Britain.

In connection with his writings it may be mentioned that he was always a diligent and accurate meteorological observer. Before he left Exeter he published a sheet of his results there for ten years, which comprises a wonderful amount of valuable information in a small space, including several points peculiarly his own, and not the less important from their being unusual in such records. A short paper of a later date, founded on his observations at Highweek, and entitled "On the Amount and Distribution of Sunshine," was read by him at the meeting of the Devonshire Association at Torquay in 1864, and published in the first volume of the Transactions of the Association. He also read an excellent paper, at the meeting held at Tavistock in 1866, on the "Principles of Rythm as applied to English verse." This, too, was printed in the Transactions.

In relation to the classics, he was almost enthusiastic in his love for the language and literature of Greece, with which he was particularly familiar. He published a "Greek Grammar," in which he greatly simplified the declensions of the nouns and the tenses of the verbs, and got rid of all super-

fluous technicalities. He also published a little work entitled "Greek Roots in English Rhyme," in which he strives to render the Greek primitives familiar even to children, by amusing couplets easily remembered. He wished to naturalize Greek among us, and to make it at least as easy as Latin or French.

His English translation of "Hephæstion on Greek Metres" was highly creditable to his classical scholarship: probably no man of our times was capable of doing more justice to that very difficult author, or better expounding the laws of Greek quantities and accents. As indicative of his critical proficiency in Greek, may be also mentioned his essay on the "Ictis of Diodorus Seculus," written at Penzance, and published in the Transactions of the Royal Geological Society of Cornwall. It is an excellent specimen of terse and cogent reasoning, directed by sound scholarship; and the identity of the "Ictis" and St. Michael's Mount is so well established by him, that the late Sir George Cornwall Lewis—the most eminent authority on the intercourse of the ancients with these parts—was induced by Dr. Barham's reasoning to retract the judgment he had pronounced on the opposite side.

Another incident which ought to be recorded is, perhaps, unique as an evidence of an Englishman's application of classical attainments to the service of the literature of modern Greece. He spent some months at Athens about ten years before his death, and finding that some of the sounds of our English consonants were most awkwardly represented in modern Greek by the union of two letters, he wrote a paper on the subject in ancient Greek, containing suggestions for remedying the inconvenience; and this was read and cordially received within the precincts of the Athenian temple, where the learned men of the day now assemble.

Leaving the mention of his literary productions, and adverting to more personal characteristics, it may be said of him, that though careless about dress—still more careless about its adornings—he was a perfect picture of the well-bred and cultivated man. His manner, no doubt, was the produce of early habits and long association with what is called "good society," to which he was ever welcomed, and to which he brought no small contribution of valuable experience, extensive reading, and appreciative criticism. His very name created for him a social *status*; for it has been borne by many remarkable persons who have figured in public and parliamentary history. The family profess to trace their history back for nearly forty generations to Rollo

the first Duke of Normandy. Their first name was Foster—still preserved as an adjunct—that of Barham having been added on the accession of some West Indian estates.

The house he built—in which he passed his later days, and in which he died—was a fit domicile for a philosopher who recognized no standard but that of his own honest thoughts. Yet he never had a guest—and he had many—who did not recognize in his domicile a kind though simple hospitality, and beneath the rough externals the real jewel.

His opinions have been thought to tend towards socialism, and, in so far as socialism is benevolent in its purpose and beneficent in its action, he might properly be deemed a socialist. But to no human being was violence more abhorrent. For his *Philadelphian* notions he sought and found arguments and authority in those ancient records to whose study he was so much devoted; and it must be owned that all generous and imaginative minds have some Eutopia in the long vista of ages, and are dreaming of a futurity in which present grievances will be redressed, and human felicity be maximized. Is it a matter of wonder that in his own person and surroundings the doctor should have desired to present a picture of what to him was a happier state of things?

As a magistrate he was assiduous, just in his decisions, and a diligent guardian under the poor law; in his family, beloved and honoured. He died suddenly, on March 3rd, at the very moment when he was engaged in thinking, writing, and about to preach, on "death." The sermon has been since published under the title, "The Prospect of Eternity." But death to him was no perplexing, no alarming, event; and he was serenely conveyed over that mortal bridge which brings us to eternity.

It remains to mention that his connection with this Association commenced with its formation, and terminated only with his decease.

ON SPONTANEOUS GENERATION; OR, THE ORIGIN OF LIFE.

BY EDWARD PARFITT.

LIFE is one of the great problems that has engaged the attention of the most profound thinkers and writers of both ancient and modern times. In our own time this problem seems to have excited more to investigate its mysteries than that of any other period of which we have any record, and more experimental philosophers have entered the field now than at any other time; and even now philosophy and chemistry have failed to explain what that wonderful *vis vitæ* really is.

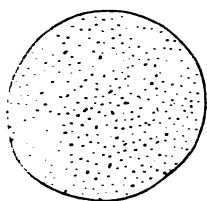
It is the opinion of one or two of our philosophic naturalists that the distance between them and the vital spark is gradually becoming less; that they are, in fact, enclosing it within a wall of argument and experiment, and that at last it must yield to their investigation. "But even if it could be shown that the chemical actions that go on in the organism are no other than what can be imitated in the laboratory, it would still be certain that life is not a mere resultant from any physical and chemical forces, and that there must be a distinct vital principle."*

It is the opinion of some that the act of crystallization and the *vis vitæ* or vital force are one and the same thing. In this I cannot agree. There appears on the surface a great similarity, I admit, and the laws which govern the formative process would appear to be identical; but having arrived at the ultimate form in crystallization, there the matter stops. On the other hand the case is very different in its results; for an animal or plant, be it ever so low in the scale, is each endowed with a property peculiar to an organized body; namely, that of reproduction.

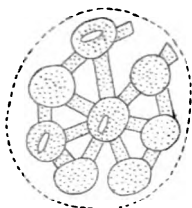
This then at once separates the organic from the inorganic kingdoms. The perpetuation of the vital principle as compared with the highest forms of crystallization, and which, so far as we know, we may term the ultimate, is to my mind separated at once and for ever by the perpetuation of the vital principle.

* Murphy; "Habit and Intelligence," vol. i. p. 88.

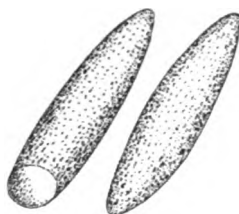
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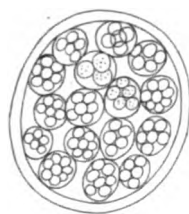
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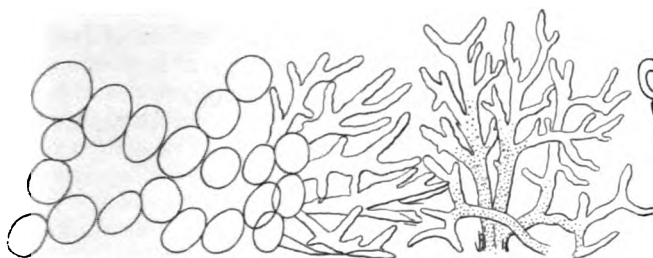
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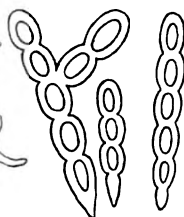
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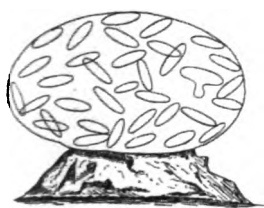
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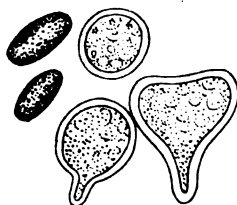
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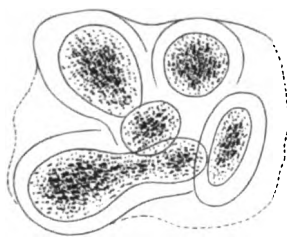
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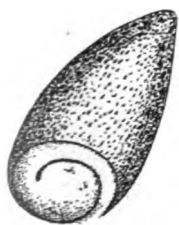
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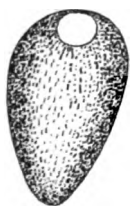
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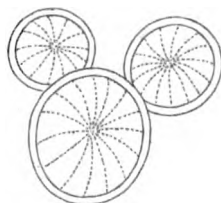
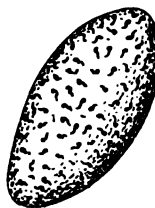
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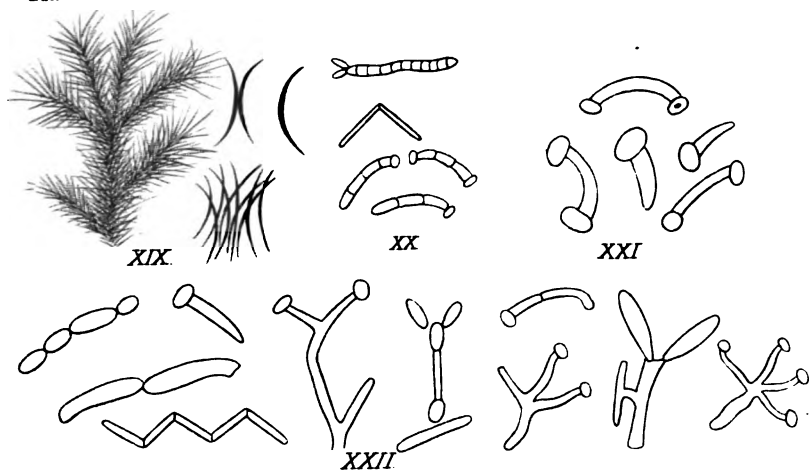
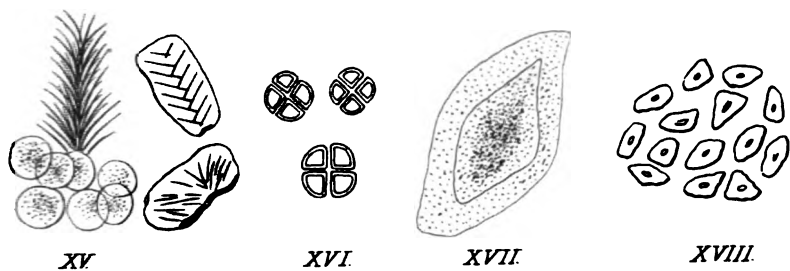
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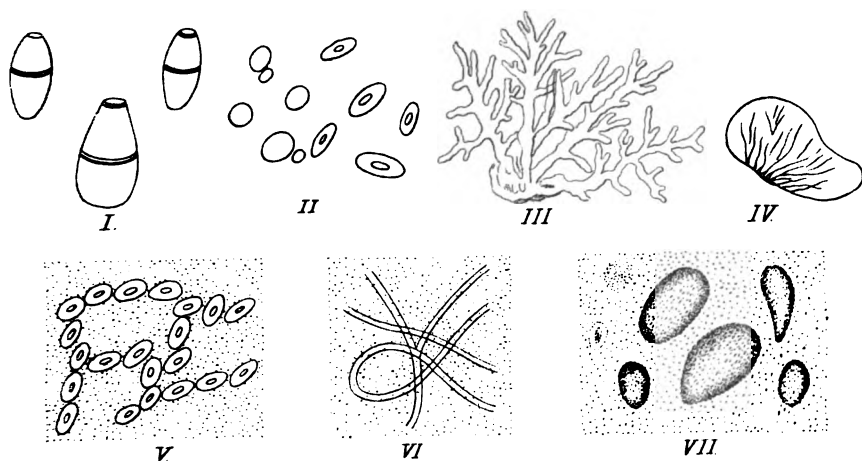
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Buffon imagined life-like matter to be indestructible, and that each organism was built up of a number of molecules, and that each molecule had a life of its own, and the death of one of these complex compounds was simply the dissolution of one of these associations; and thus he says, these molecules are again set at liberty, and wander about until they are once more combined with an animal or a plant; and as Coleridge has beautifully said—

“Organic harps are living things,
That tremble into thought,
As the one breath sweeps o’er their strings,
The mind that has them wrought.”

Spinoza, who held a rather different opinion to that of Buffon, believed that there is in nature only one substance, and that this substance is infinitely diversified, having within its own essence the necessary causes of the changes through which it goes.

In the investigations into the development of life, and to which the title of *Spontaneous Generation* has been given, I shall have to direct your special attention. We have in this something similar to that which Buffon alludes when speaking of “the wandering molecules;” for when the portions of the organisms have become disintegrated or broken down, the molecules and cells of which they were formed are set free, and it is to the study of these in their separate and also in their aggregate forms that I shall have to direct your attention. A molecule is believed to be an aggregation of atoms; and it is only in the molecular form that we are able to recognise matter in its highest state of disintegration; and although we are enabled to examine with our instruments the apparently extreme points of matter, yet there is a world which lies beyond, as yet invisible—the “atomic.” One of the most recent and apparently one of the best informed philosophers in treating of this subject—the “atomic theory”—*—Professor Bayma—believes each atom to be spherical in form, and surrounded by a repulsive electric ether, the atom itself being attractive; and that every point of matter acts instantaneously upon every other point at all distances, however great or small, with a force having the same character at all distances, and inversely to the square of that distance. But I hold with Professor Norton that this is assuming too much, as no proof has been established that an atom is spherical in form, or that it is a material point. “In fact, it appears to be highly probable, as supposed by Brodie, and strongly urged

* “Philosophical Magazine,” 1869.

by Gerhardt and his followers, that few if any elementary substances in their uncombined condition are really known to us; the so-called elementary bodies being really compounds of at least two atoms of the true element with each other. Thus hydrogen gas is not simple hydrogen, but is H_2 , or H hydride of hydrogen, and so on with others.*

We set out, then, as Mr. Herbert Spencer† says, "With molecules one degree higher in complexity than those molecules of nitrogenous colloidal substance into which organic matter is resolvable; and we regard these somewhat more complex molecules as having the implied greater instability, greater sensitiveness to surrounding influences, and, consequent greater mobility of form. Such being the primitive physiological units, organic evolution must begin with the formation of a minute aggregate of them—an aggregate showing vitality only by a higher degree of that readiness to change its form of aggregation, which colloidal matter in general displays. A further stage of evolution is reached when the very imperfectly integrated molecules forming one of these minute aggregates become more coherent, at the same time as they pass into a state of heterogeniety, gradually increasing in its definiteness."

Dr. Winslow,‡ in speaking of the forces exerted upon molecular matter, says, "In whichever light we study the action and reaction of these binary elements of mechanical energy, or *vis viva*, we observe all the phenomenal results in crystals, plants, or animals to develop themselves upon crucial and bilateral principles, and all the secondary forces to follow the same axial and equatorial lines of propagated molecular force and motion."

This is exemplified in a remarkable manner in the molecular movements in all the experiments that I have instituted. We first observe a homogenous molecular mass (fig. i.) floating or suspended in water, which has been added; and almost as soon as the infusions have become cold we observe a remarkable movement has taken place with the molecules; part of this is, I presume, from the loss of heat. They have already begun to form themselves into some definite shape. (Fig. ii.) There have then been forces at work imperceptible to us, except that we see the results of those powers in the formative process that is going on. The same, or apparently the same, formative process may be seen, I admit, in the act of crys-

* "Miller's Chemistry," vol. iii.

† "Principles of Biology," vol. i. p. ii. 12.

‡ "Force and Nature," p. 282.

tallization, as the suspended molecules are drawn towards each other by a force that is termed affinity or attraction; but when the crystal is formed, the process is complete. This same process may be repeated by the addition of other and similar crystals, but this is all; here crystallization ceases; it can go no further. The same laws that govern both organic and inorganic matter, when each are placed in similar conditions, appear to act the same on both; the same influences are exerted on both, and apparently in the same degree; indeed, the two seem to run in parallel lines to a certain distance; at last the inorganic stops; it has reached its ultimate form. Its hitherto companion is still acted on by the same forces: it is carried forward, and here the true *vis vitæ*, or life-force, is really seen. We now see distinctly the difference between the organic and the inorganic kingdoms. When the two started, we saw what we believed to be the same energy acting equally alike on both—the *vis* or force, the *vitæ* or principle of life, had not then manifested itself.

But the very fact of life being transmitted or carried forward implies a force or energy. At the same time it is not a mere mechanical force such as we saw at work in the formative process of crystallization, but a life-force, a force that implies that some other and peculiar property is bound up with these mechanical forces. "Force so combined with force as to produce certain definite and orderly results: this is the ultimate fact of all discovery."*

Mr. Browning, in *Transactions of the Royal Microscopical Society* for this month (July, p. 18), says: "There are probably some grounds for believing that the particles or molecules in magnets are always in motion; and," he says, "Mr. Wenham once told him that he had seen a cavity in a crystal partially filled with a fluid, and for several years this fluid had been unceasingly in motion, although completely shut off from the surrounding atmosphere. Motion then," he says, "is not peculiar to life; and we shall be brought at last to the single distinction—reproduction." In this I fully concur, as I had arrived at the same conclusion, as before stated. Mr. Browning goes on to say, curiously enough, in the very next sentence, that what he had just approved is not true, and cannot be accepted; for, he says, "The difficulty here would be insuperable, if we were compelled to accept the hypothesis that life is transmitted from one organism to another. But this hypothesis is no longer generally accepted. Professor

* Duke of Argyll; "Reign of Law," p. 81.

Owen, who has been until recently opposed to such views, has at length accepted the hypothesis of spontaneous generation." This passage, I think, would puzzle a Philadelphia lawyer.

The term "spontaneous generation," although it expresses a certain meaning, I think is not admissible; for although we see things apparently springing into life where no life appeared to exist, and yet in a few hours every molecule is a moving, living body. In this light it seems to me more like suspended animation; and that every molecule, directly it is set free, is seen dancing about in the infusion, like gnats in the sunbeams, and apparently as full of the enjoyment of life. And it would also seem as if an organism was composed of an infinite number of these, and that, when set free, they returned to their original conditions; for the great variety of both animal (or what we believe to be animal) and vegetable forms, which are developed in a single infusion of either animal or fish, would almost warrant us in believing such to be the case; but at present it would not be prudent to venture so far.

Again, when we examine our infusions, whether they be made with vegetable or animal, we detect life, or what we believe to be life (and not mechanical force), in the most minute points or molecules that our instruments enable us to observe; and why I believe this motion to be life is, that we see the molecules in different stages of development. At the same time I am fully aware that motion does not distinguish an animal from a vegetable, as many plants are endowed with that property.

The most minute and searching microscopic investigations have availed us but little in the elucidation of the mysteries of life. One great thing it has done for us, and that is this, it has opened up a vast field of research, and carried our knowledge into infinitesimal matter, in which it thins away until it seems to vanish into thin air, and yet as far as the eye can see does life reside. The minute cells of which both plants and animals are built up, the very petals of the flowers, and the eyes of the human subject, are swarming with life, not their own, but myriads of independent creatures, so that at last we are almost forced to accept the words of Buffon, referred to in the first part of this paper.

Thales supposed all things to be generated out of water; and in this he was not far wrong, as the beginning of life, so far as we are enabled to appreciate it, is mainly dependant on a certain state of humidity for its existence. Amongst the protophytes, or simplest plants, there are many of which

every single cell is not only capable of living, but may be normally considered a distinct plant. For instance, observe the beginning of a lichen on a newly hewn stone. It will there be seen to spring from a single cell, and this cell, should the condition of humidity continue favourable, will very soon develop others, so that in a short time a thin stratum of cells may be observed radiating in all directions.

In the infusion of the liver of a fowl, and to which I shall again have to refer, I observed on my first investigation, eighteen hours after the infusion was made, a number of bluish elliptical cells, very much like the spores or cells of a *penicillium*; these had the power of propagating or continuing their like by a kind of gemmation, that is, the inner walls of the cells appear to develop minute gemmæ, or little buds, which spring into cell life; and it frequently happens that one single cell may contain many generations of cells, as they are graduated down to extremely minute points, and at length lost to view. These cells propagate very rapidly, forming themselves into long moniliform masses. Now the difficulty is how to account for these cells in this infusion, as I had done all that I could do to destroy life, by boiling the liver until it was all, or very nearly all, broken down or disintegrated, so that it appeared only as a molecular or flocculent mass. These cells measured about $\frac{1}{12000}$ an inch long. My impression is, that these cells were imbedded in the flesh of the liver, as I do not believe them to have been admitted through the agency of the atmosphere into the vessel, as every provision was made to render the experiment as perfect as possible.

Dr. John Lowe* mentions the case of cells being found in the lungs and kidneys of a man. These cells measured $\frac{1}{10000}$ of an inch, which correspond very nearly with the size of those found by me in the liver of the fowl. I do not agree with M. Pasteur in ascribing to the agency of the atmosphere the various vegetable cells that have been found in the numerous infusions that have been made in the investigations of this so-called "Spontaneous Generation;" for although I have studied fungi for at least twenty years, I have never found them so abundant as to fill the atmosphere so completely with sporules as some would have us believe, and that at all seasons of the year, and in every condition, in the still atmosphere of a room equally with that in the open air.

The extreme difficulty of destroying life I have found in every experiment, for neither baking nor boiling will destroy

* "Edinburgh New Philosophical Journal," 1860.

it; these may change the form and outward condition of the things operated on, but you cannot drive life entirely out of it by either of these processes.

The greatest heat that has been applied to experiments of this kind is 200° centigrade, or 500° F., and even then, says M. Pouchet, animalcules and fungi are developed. "Neither calcined air, sulphuric acid, liquor potassæ, gun cotton, nor a boiling temperature have failed to prevent the production of infusoria, or destroy the supposed germs in the air or infusion."*

If we take the case of *sarcina ventriculi*, as found not unfrequently in the human stomach, and also the vegetable sporules found in the kidneys; the temperature of the stomach averages about 98°. And again, take plants such as *ulva thermalis*, and others, which live in the hot springs. But it may be said that these plants are adapted to places in which they are found, and it is consequently natural to them. Be it so. But still it shows us that a heated medium is not antagonistic to vegetable life. M. Pasteur says, that the boiling temperature, that is, 100° centigrade, does not prevent the growth of the germs in the atmosphere; but, he says, that 130° centigrade always destroys their vitality. This, it will be observed, is directly opposed to the experiments instituted by M. Pouchet, as before stated, that the temperature of the infusions may be raised to 200° centigrade, and yet animalcules and fungi are developed.

There is one very remarkable thing to be observed in nearly all the experiments that I have prosecuted, and that is this, that nearly all the larger and stronger plants, if I may call them so, have sprung from the oil globules. This may be said to be in favour of M. Pasteur's argument, that the germs are admitted with the atmosphere; and as the oil, being lighter, it generally floats on the surface of the infusion, the germs are first brought into contact with it; and finding a proper and rich medium in which to vegetate, they rapidly spring into life, the result of which we see in our microscopic examinations of the infusions. This, although it appears so favourable to M. Pasteur's hypothesis, is not true in the main; for I have carefully examined other parts of the infusions, and particularly the flocculent matter, which also contains oil globules, and which is generally held in suspension, and floats near the bottom of the infusions, to be quite as abundant in vegetable organisms as those masses which float on the surface; and in the case of the liver of the fowl, a small

* Dr. Hughes Bennett, in "Popular Science Review," January, 1869.

portion which remained entirely at the bottom of the vessel developed one of the largest growths that I have yet seen, and which I believe belongs to the genus *Leptomitus*, and is very nearly allied to *L. lacteus*, but it differs from that species in not being constricted at the joints. Again, on this same piece of liver arose a rather large inflated film, or what appeared to me a protoplasmic or structureless thin jelly; this never was brought into contact with the air at all, except when I took up a portion of it with a glass tube, to place it under the microscope; and yet this film had imbedded in it quite a network of elliptical sporules, not molecular bodies, but having all the appearance of sporules of some mucorinous plant. This then to me, who saw this remarkable structure, would prove a great stumbling-block to the acceptance of M. Pasteur's theory. This structure appeared on the eighth day after the infusion was made. (See fig. viii.)

I began my experiments in this way: I prepared three glass vessels by thoroughly cleansing them and boiling them; I then dried them at the fire. I then took part of the liver of a fowl directly from the bird, and placed it in one of the vessels, covering it instantly it was taken out; I then poured about two inches of boiling water into it, keeping it covered, except when the water was being poured in. I then took a piece of beef, of about half-an-ounce in weight, cut directly out of a larger piece, so that it should not be brought into contact with the atmosphere more than was possible, and placed this in the second prepared vessel, keeping this covered as before. I then took a saucepan half-filled with water, into which I placed two of the vessels, keeping them carefully covered all the time with stout paper covers, leaving a long curtain of paper reaching half-way down the vessels, so that what air got into the vessels must make a circuitous route. I then boiled the contents of the vessels for fifteen minutes, when the liver had nearly all become disintegrated, and the beef had begun to break down, and was giving off masses of flocculent matter, both making a more or less coloured infusion. Night having intervened between the boiling and the examination, but at nine o'clock the next morning I found each infusion tolerably clear, the colouring matter having become deposited at the bottom, and each infusion was covered with a thin pellicle, which was filled with minute points of the disintegrated liver. The molecules of the liver were, as a rule, smaller than those of the beef; but in the liver I observed, beside the molecules, some larger bluish-looking cells, about $\frac{1}{1000}$ of an inch long; I also observed a

few in the beef. (Fig. ii.) The molecular mass in the pellicle of the beef infusion had already begun to assume a definite form. (See fig. ii.) After this I saw no great change in this, except that it followed closely in the wake of the transformations of the molecules of the liver, and which will now claim our special attention. The contents of the third vessel, which contained an infusion of fish, will be alluded to further on. On the third day the principal portion of the molecular mass had arranged themselves into long tubular lines, the tubes being formed of a very thin transparent film. (Fig. iii.) This protoplasmic and structureless substance is very remarkable, and is found in all the infusions that I have as yet had under experiment, and in this the greater part of the molecules are seen to be imbedded; and it appears to me that this is what is acted on by the forces before mentioned, and which becomes moulded into the various forms that more or less approach some of the recognised animalcules.

The substances which we are discussing appear to me to divide themselves naturally into four divisions; thus, first we have the molecules; secondly we have the structureless substance; thirdly we have the oil globules, or cells; and, fourthly, we have what appear to be vegetable cells, or spores of some mucedinous plant. The latter were so distinct that it would be impossible to confound them with any thing else seen in the infusions; and from their being found in the flocculent matter, and also imbedded in the film, as seen attached to the piece of liver at the bottom of the vessel, I do not believe them to be obtained from the atmosphere. On the fourth day the oil globules were very numerous, and varying from $\frac{1}{1800}$ to $\frac{1}{1200}$ of an inch in diameter, each having a double wall; the interior was entirely filled with what appeared in the smaller cells to be a grumous mass, but the larger cells showed what this really was, namely, a mass of cells, and these again were filled with smaller cells, and so on, until they were lost to view (fig. iv.); so that one large cell contained many generations of cells, something after the manner of Dean Swift's celebrated lines, (altered a little to suit the subject,) that the

Great cells have little cells,
And lesser cells inside them;
The lesser cells have smaller cells,
And so on *ad infinitum*.

The next day these larger cells had burst, and their contents had formed themselves in long, moniliform, decussating lines (see fig. v.), and from a group of these I observed another,

and quite a distinct growth, had sprung, agreeing in the manner of branching to a plant I shall next have to mention. The mycelium-like threads measured about $\frac{1}{1000}$ of an inch in diameter, and they had just the appearance of the mycelium of some fungus. I tried to find the nucleus or spore from which these mycelia had sprung, but I could find none. The only thing I observed was that they appeared to me to spring from this group of cells. Both these groups of cells had a yellowish-blue colour, I presume from refracted light.

On this same day (the fifth) of the experiments there appeared at the bottom of the infusion of the liver a remarkable plant. (Fig. vi.) It sprung from a small piece of liver lying at the bottom of the vessel. This grew from a very small speck when first observed to six lines in height by the seventh day. The filaments of which the plant is composed are hollow, and with the highest magnifying power I could apply I could observe no cellular structure. It branched in a dichotomous manner, and the tubular stems were filled more or less with a grumous mass, very thick towards and at the base, but gradually lessening in mass and density upwards, so that the apical portion of the main and lateral branches appeared free and transparent. The diameter of the principal branches were about $\frac{1}{1000}$ of an inch in diameter. This plant grew very rapidly until it nearly reached the top of the infusion, and at this time I clearly saw that it belonged to the genus *Leptomitrus*, and that it was very nearly allied to *L. lacteus*, only that it was not constricted at the joints or septa. I shall name this plant provisionally *Leptomitrus ktisma*, which means a created thing. On the 12th day it had reached the top of the infusion. The exposed portion turned to dull pale olive green, and reflected a bluish tint, and when I took some of it up to examine it, the portion so taken seemed to me to be entirely alive with moving elliptical bodies, measuring from the $\frac{1}{15000}$ of an inch long, and graduating down to the most minute point. These were exceedingly active, moving about in all directions. When seen singly they appeared of an opaque white, but seen *en masse* they had a pale olive green colour. I observed that here and there one might be observed longer than the others, as if two or more had become fused together. These would all of a sudden start off across the field of view, driving any others that might happen to be in their way aside; and the others, when they had full room to move, would swim with a whirling or gyrating motion.

On the sixth day I observed a curious growth, apparently springing from one of those bluish-looking sporules before

mentioned. These have, as you observe, somewhat the appearance of some of the asci of the genus *Peziza* or *Ascobolus* compressed, clavate, but constricted between the sporules, the fronds measured $\frac{1}{100}$ of an inch long. I only saw this one group, and therefore cannot say what it really is. It is probably a plant in an incipient form, but I know of nothing like it amongst British plants. (Fig. vii.)

The eighth day revealed a very curious and interesting development; not exactly a plant, but a number of elliptical cells appeared imbedded in an inflated bubble, caused, I presume, by the generating of some gas from a piece of liver lying at the bottom of the vessel: the rest of the liver was also covered with a film of this protoplasmic substance. These cells were very evenly scattered over the bubble. (Fig. viii.) A few of them had united and become more elongated, and one or two had either had others attached and become fused together, or that a long cell had thrown out a short branch at right angles to the larger or parent cell. The average length of the single cells was about $\frac{1}{100}$ of an inch long. How these cells had become imbedded so evenly in this film, or how they came there at all at the bottom of the infusion, I cannot imagine: I do not believe in their coming from the atmosphere. The surface pellicle at this time was swarming with the so-called *bacteria* and *vibrios*, in different stages of development.

From this up to the 14th day I observed no particular change, but now the vibriones had become much elongated, similar to those figured by Dr. Hughes Bennett, in *Popular Science Review*, page 53, fig. 2.

The beef infusion had at this time developed plenty of *bacteria* and *vibriones*, and three large patches of *Penicillium crustaceum*, which occupied nearly all the surface of the fluid, but no other plants were observed in it. This plant did not make its appearance at all in either of the other vessels.

Fifteenth day the pellicle of the liver showed several dense patches of cells, varying very much in size, and of various forms, the smaller ones being generally spherical, and the larger ones more or less angular, the larger being filled with cellules in various stages of development. This was almost the first bright or sunny morning since the commencement of the investigations, and the *vibriones* were exceedingly active, moving about in various directions, and gyrating, reminding one very much of the gambols of *Gyrinus natator*.

Sixteenth day I observed imbedded in some flocculent matter of the liver, suspended near the bottom of the vessel,

some curious cells, very much like the nucleus bodies found in the sarcode of *Gromia*, as figured by Schultze and Carpenter. The large cells were filled with a molecular mass, in various stages of development into cellules. In the large pedunculated cell you will observe that the molecules have arranged themselves somewhat into lines, particularly towards the peduncle, and gradually developing upwards into cellules; the lines of demarcation could be just discovered. (Fig. ix.) In the spherical cell these lines were rendered more distinct, the cell having apparently reached a higher state of development. The development of cell structure from the molecular mass was seen to great advantage in these large cells, better perhaps than from the larger masses of molecular matter. We first observe the enclosed molecules are being acted on by some force or forces as they begin to arrange themselves into various groups, drawn together into centres, and consequently the lines between these centres are rendered clear and transparent, and from these it would appear that the protoplasmic film grows, and envelopes the nucleus of molecules. In a short time the molecular mass in these enclosed cells also begins to divide in a similar manner. So the development goes on, dividing and subdividing, and at the same time the continuation of life.

The 17th day was cold and dull. I could not discover anything different from what I had seen before.

On the 18th I observed some of the highest developed forms that have yet been discovered, either by M. Pouchet, Dr. Hughes Bennett, or, so far as I have seen, any one else. M. Pouchet describes this, or a form figured by him which I take to mean the same thing as this, to be the ova of *Paramecium*. At first I observed a number of groups of molecules collected together into various shapes, and some appeared in the act of dividing, or as if a larger and a smaller had joined together. (Fig. x.) Each of these groups was enveloped in a proligerous membrane, and at a little distance from this was to be seen another membrane, and these again were attached, or rather imbedded, in another free one, which outer one was thickly studded with molecules of matter, and the whole infusion was swarming with vibriones, which appeared larger than I had before seen.

We now come to some remarkable forms, which appear rather more advanced than those figured by Pouchet, and copied by Dr. Hughes Bennett;* but if they be the same, only in a different position, I have found that what Pouchet

* "Popular Science Review," fig. 5, page 55.

took to be a nucleus is in reality an orifice. In this case they would come very near to, if not identical with, *Proterodon niveus*; but these are more pyriform. But I could not detect the toothed mouth, or the polygastric system. (Figs. xi. xii.) These organisms were constructed of the protoplasmic film, thickly studded with molecules, which latter were rather larger than the generality, and were more sharply defined. It will be observed that the orifice of one of the specimens is at the larger end, whereas in the others it is at the smaller end. These specimens measured about $\frac{1}{10000}$ of an inch in their widest diameter. One specimen I observed quite different from the rest. The protoplasmic film had rolled itself round a long axis, and formed an orifice very much like the genus *Stentor*, and which this specimen also reminded one of in its elongated form. (Fig. xi.) The molecules imbedded in the film forming this organism were arranged, more or less, in longitudinal lines. This measured $\frac{1}{10000}$ of an inch in its widest diameter, by $\frac{1}{10000}$ of an inch long. I could not discover any movement in these, either ciliary or otherwise.

On the 20th day we arrived at the highest development in the direction of animal life that I have been able to obtain; that is, if we except some very remarkable vibri-ones that I observed on the 38th and 44th days. This, as you will observe, is a hollow ellipse, and is formed of the protoplasmic film, and is rather sparsely studded with what appeared like very minute tadpoles. (Fig. xiii.) This form agrees very nearly with the genus *Sphaerosira volvox*, as figured by Pritchard, edit. 1842, t. i., figs. 48, 49. The protoplasm in which these animals were imbedded had a faint reticulated appearance, which would make it rank nearer the genus *Volvox*, and the animals could be seen waving and wriggling their tails between the meshes. Vibriones were at this time very abundant, and amongst them I observed a number of white, spherical, transparent bodies rolling through the fluid, just the kind of movement one sees in *Volvox globator*. These I believe to be *Monas umbra*, as they agree in size with that species, $\frac{1}{10000}$ of an inch in diameter.

Dr. Hughes Bennett says: "It frequently happens, that soon after some of these higher infusoria are seen, that the pellicle falls to the bottom of the fluid, where it constitutes a dense precipitate, and slowly breaks down; then another scum forms on the surface, and molecules, bacteria, and vibrios are again produced."

"The varied forms produced are spoken of by Ehrenberg and other naturalists as being different species, but I think it

will be found that the laws, not only of molecular but of alternate generation and parthenogenesis, prevail among them, and one frequently passes into another."* But a little further on he says: "In all cases no kind of animalcule or fungus is ever seen to originate from pre-existing cells or larger bodies, but always from molecules."

The various forms as spoken of by Ehrenberg might under certain conditions constitute what we are pleased to call species, but we have only seen them under one condition, and that one condition has revealed these forms very distinctly, as distinct, in fact, as many so-called species, and, so far as we know of them, they seem equally entitled to rank as such. Could their existence be prolonged, and that they could be placed in more genial media, the probability is that we might see them develop into other forms. In one instance I tried this by taking what M. Pouchet has described as the perfect ovum derived from the molecular mass. I placed it in a watch-glass half filled with water, and covered with a bell-glass, but at the end of a fortnight I could discover no permanent or particular development, only that the molecules had become slightly larger. But there is one thing to be observed here, the specimen might not have been placed in its proper medium, and it might not have been supplied with proper nourishment for its further development. It would therefore be wrong to say that this microcosm had reached its ultimate form. The great fact then is, that we can to a certain extent see the beginning, but we cannot at present see the end.

On the 22nd day these curious and beautiful forms revealed themselves. I observed five of them in a group, varying in size. The largest measured 12·000 of an inch across. They were tinted, of a pale green colour. The periphery was double, like an oleaginous cell, and the molecules radiating very regularly from the centre, and it appeared to me to be formed like a concavo-convex lens, or hollow or concave on one side and convex on the other. What this really was I cannot tell, as this was the only group or specimen that I have seen, and I know of nothing like it. (Fig. xiv.)

23rd day. We now come to a very curious vegetable growth, springing from what appears to be only an irregular oleaginous cell; for I could not discover with the most careful investigation anything like a true vegetable cell inclosed in the oil cell, and I have had frequent opportunities of watching the growth of this from its first appearance, as the plant has been very frequent in the liver infusion, but I saw nothing of it in the beef. (Fig. xv.)

* "Popular Science Review," pp. 55, 56. 1869.

The plant first appears, as I have endeavoured to delineate it, in attached or free fusiform slightly curved sharp-pointed fronds. They arrange themselves with their convex sides together, and they have then just the appearance of that curious Desmid *Ankistrodesmus falcatus*, Corda, and to which this seems nearly allied. On the 34th day I noted a large mass of this plant; it had then attained to the $\frac{1}{4}$ of an inch high, and the fronds of which it was composed measured about $\frac{1}{1000}$ of an inch. It had a very remarkable appearance, and reminded one somewhat of the marine plant *Sphacellaria scoparia*. I observed that the young fronds of this plant when found free in the protoplasmic film are at first quite colourless. They afterwards attain to a pale olive-green tint, and when full grown to an olive-green. I have given the name of *Chlorocyclos fasciatus* to this plant, which means a bundle of green semi-circles. (Fig. xix.)

From the 23rd to the 26th day I did not observe any particular change, or any further development; but on the latter day I observed a group of cells, varying in size, the largest measuring 5·000 of an inch in diameter. Each was divided into four sections by broad dissepiments, and each being provided with a double wall. They were of a delicate green colour, and reminded me very much of the cells in *Ulva crista*. (Fig. xvi.)

On the 34th day the beef had developed some rather different forms to those of the liver, and particularly some masses of angular cells, imbedded in a transparent film. Each angular fragment or cell had a distinct round or elliptical nucleus; some of the larger had two. These angular cells are crowded with molecules, except the nucleus, which is free. The beef appears to me to break up into these angular cells; for when a small bit was placed between slips of glass and pressed, it broke up into little tessera, each being held together by a transparent film. (See fig. xviii.) These cells vary in size from the 2·000 to 2·500 of an inch in diameter.

On the 38th day the vibriones had attained to a large size, and were three or four-jointed, most of them having a large globose head; and I observed that the portions between each articulation were slightly curved, and having a faint bluish tint. Professor Clarke, in his investigations into the structure of muscle and muscular fibre, says, although with great reluctance, he must admit the truth of what he has seen, and that is, he has observed portions of muscular fibre, or the fibrillæ, break away from the mass and swim away as vibriones. So that in fact the common muscular fibre of ours and other

bodies appears to be only collections of vibriones, remaining in an inactive state until liberated by the decomposition of the matter holding the vibriones together.

Now the fibrillæ of portions of muscle that I have examined from the liver of a fowl gives me just the idea of vibriones being packed together transversely: they are the same in colour, the same in measurement, and the articulations are the same distance apart, and I believe it would be impossible to separate the free fibrillæ from the vibriones. I have myself seen two or three fibrillæ partly liberated from a piece of muscle moving about in the same manner as the vibriones; but when all the infusion is a mass of life, I could not positively say that what I saw was voluntary motion. At the same time, I feel convinced in my own mind that it was so.

I now come to the last group to which I have to draw your attention, and these are some very remarkable vibriones. Generally speaking, these animals are simple—one to three or four articulated cylindrical creatures; but though the greater part of those in the infusion were simple, there were also amongst them a great many branched forms; some of the most curious I have sketched here. (Figs xx. xxi. xxii.) These were observed rolling and tumbling about the fluid in a very remarkable manner. They were all tinted of a delicate blue colour, and those that I have sketched measured from $\pi\pi\pi\pi$ to $\pi\pi\pi\pi$ of an inch long. In the earlier stages of vibronic life they are without the rounded heads; they seem only to take it upon themselves to wear heads at all towards the latter part of their lives. Some I observed in the beef infusion on the 52nd day had monstrous heads, belonging evidently to the *Macrocephali*. Some had two heads, one at each end; but these, I presume, would divide at the septa, and form two animals.

I will conclude with relating the experiment I prosecuted with the third vessel that I mentioned at the commencement of this paper. I began, June 8th, at two p.m., by taking a thoroughly clean glass vessel, and scalding it with boiling water. I then took out a piece of mackerel from the most fleshy part of the back towards the head; I carefully turned back the skin, so that the part I took should not have been brought into contact with the air or water in washing. The mackerel from which the piece was taken was brought directly from the oven, cooked, ready for eating. The vessel was kept carefully covered from the first, so that nothing should fall into it. Some boiling water was poured on the piece of fish to the depth of about an inch; this was then stood on the

top of the kitchen hot-plate, which, I must say, was nearly red hot; it was left in this position for nearly an hour, when I considered it had had quite cooking enough. It was then left to cool; and it was all this time kept carefully covered with stout paper, and tied down. At six o'clock I examined some of the oleaginous cells in the thin pellicle that had formed on the surface. Some of the cells were round, others ovate or elliptical; the latter showed two very dark bands, one broad one near the middle, and the other near one end. (Plate II., fig. i.) At this time I could not discover any life in the vessel; at the same time I do not say it was not there.

At nine o'clock the next morning the whole infusion was a mass of life. Every particle that had been liberated in the cooking and heating afterwards (and they were very numerous,) appeared to me to be endowed with life, that is if we are to regard animated microscopic matter endowed with voluntary motion as containing the property termed life. Some of them appear only as animated cells, some of which were spherical, and others elliptical; the latter had each a central nucleus, like a well-defined ring, the centre of which was transparent. The spherical bodies measured from $\frac{1}{1000}$ to $\frac{1}{1500}$ of an inch in diameter, and were what I believe are called *Monas crepusculum*.

The fibre of which the flesh of the mackerel is composed, when highly magnified, is seen to be transversely striated, very much like the fibrilla of muscle alluded to before. These fibrilla break up, where these transverse striæ are observed, into minute elliptical discs or cells; and it appeared to me, that directly they were set free they moved away with a very rapid motion, the same as the little monas mentioned above.

The oleaginous cells have not been less active, for some of these had by the 10th developed a vegetable growth of a very similar character to the *Leptomitrus* in the liver; but it was not the same. (Fig. iii.) In one cell you will observe another plant is beginning to grow; it has not yet penetrated the walls of the cell. (Fig. iv.) I could not in this, or any others, discover anything like a vegetable cell, or sporule, and the growths always seem to me to spring from one side.

There were immense numbers of spherical oil-cells in the pellicle, and many of them had arranged themselves into little moniliform masses. These oil-cells are provided with double coats, the inner one reflecting a beautiful purple colour.

There were also great quantities of elliptical cells imbedded in the proligerous pellicle; these had a yellowish colour, the

cells being so numerous as to appear like an intricate network (Fig. v.) These appeared to me to be the same as had broken away from the fibrillæ of the flesh, the same as fig. ii.

On the 12th the molecules, which are quite distinct from the cells before spoken of, had arranged themselves into those ovaform masses as described by Pouchet, and the same as I have seen in both liver and beef. (Fig. vii.) I also observed to-day several fine thread-like filaments of a bluish colour, having just the appearance of much-elongated vibriones. (Fig. vi.)

From very careful watching of this infusion, it appears to me that the oleaginous cells are in themselves capable of producing these vegetable growths; for I have very carefully examined this infusion, to see if I could detect anything like a sporule or vegetable cell, and have failed to do so; and yet in about 48 hours after the infusion was made, and had passed through such a fiery ordeal, plants were developed, and grew with great rapidity.

In conclusion, I must say that I conducted all my experiments with the greatest care, so as to prevent and protect myself against objections that I am fully aware might be raised against such experiments. There is one thing which must strike every one who has paid attention to the experiments prosecuted by the various naturalists, and that is that we all obtain very nearly the same results at all seasons of the year. Whether it be in France, Scotland, or in Devonshire, the same animals are developed, the same movements and the same formative processes go on in the molecules, whether they be of fish, flesh, or fowl. The same laws are ever and constantly at work, as well in the laboratory, in our rooms, and in the open air. And so far as all our experiments have carried us, we have seen that life resides in the most minute atom that our instruments are able to detect, and with the same force in proportion to its size as that of the most ponderous creature that inhabits the globe, and yet we cannot cry, Eureka. The great mystery of mysteries remains the same.

THE PLATES.—I beg to inform the reader that the figures in these plates are not drawn to any scale. I have drawn them I hope sufficiently large to make them intelligible; and as the objects varied so much in size, the drawing them to scale would have been of no particular use. I have given the size of the largest, or what I believed to be the highest, developed forms in the body of the paper.

ON THE PROTOZOA OF DEVONSHIRE.

BY EDWARD PARFITT.

IN treating of this portion of my catalogue, Fauna of Devon, it ought really to have formed the first part; but for several reasons it has been delayed until now. The principal reason of its delay is, that I was desirous of making myself acquainted more particularly with the various forms enumerated therein.

This part (the 5th) of my catalogue then treats of what is believed by naturalists to be the basis of animal life. The lowest recognised forms, most of them, have a world-wide distribution; but more particularly those found in the sea than those forms found in the fresh waters. At the same time, this line must not be drawn too lightly; for we know but little of the distribution of the fresh-water forms (species I can scarcely call them) of other parts of the world. Mr. J. H. Carter has perhaps done more in the investigation of the forms found in the fresh-water tanks of Bombay than any *one* observer I could mention.

The lowest type with which we are acquainted is that named by Professor Huxley "*Bathybius*," met with on the sea bottom at a depth of about 500 fathoms; and the *Amœba*, found sometimes abundantly at the bottom of our fresh-water ponds and streams: in both cases they appear only as masses of animated jelly.

The *Bathybius* was found by Dr. Carpenter to be studded with two or three forms of *Rhizopoda*; namely, *Globigerina*, *Coccoliths*, and *Coccospheres*. They seemed to be imbedded in the *Bathybius*; but he does not appear to have discovered what relationship the *Rhizopods* bore to the *Bathybius*, except, as Dr. Carpenter suggests, that they bear the same relation that the spicules of sponges, or radiolaria, do to the soft parts of animals.

If this be the case, there can be no difficulty in assigning a use to the *Rhizopods* found imbedded in the mass, and they must of necessity form a very important part in the

animal economy; but their distinction must at once be sunk as distinct animal forms. At the same time, the Bathybius must be raised in the scale of being above that of the Amœba; and the Amœba will still hold its place as the lowest known form in the animal kingdom.

As far as the animality of this protozoon is concerned, it appears to be not different from that inhabiting the true Rhizopodous shells, which, from their beauty and intricate structure, we might naturally look for something higher in the scale; but we have the very same thing repeated in the fresh waters of our ponds and ditches; for no difference of structure can be discovered in the Amœba from that which inhabits the beautiful *Actinophrys sol.*, or in *Arcella*, or *Diffugia*; and yet these have the power of constructing for themselves remarkable structures in which they live; the first composed of silex, and the latter a flask-shaped house, composed of minute grains of inorganic substances, collected and arranged in the most wonderful manner.

Now the step from the naked Amœba to this *Diffugia* is a very short one, and, as I before stated, the animals or animal nature of this animated jelly appears to be the same, yet no one, so far as I am aware, has ever seen the Amœba collecting materials for constructing itself a dwelling-place. Something approaching this has been observed by Schneider; for he says he "first saw the Amœba become globular, and then to form a firm membrane on one side, whilst the other portion maintained its peculiar character and actions. By degrees the membrane extended itself over the whole body, the moveable portion constantly becoming smaller, until at last a completely closed cyst was produced, in the clear anterior of which a round nucleus with a reddish halo, exactly like that of *Polytoma* and other *Monadina*, might be distinctly observed."

To me it appears that all those so-called species which have the power of *secreting* lime or silex, and constructing for themselves a habitation or skeleton, ought to rank much higher in the scale than those which only *collect* crude materials for the same purpose. The former, I presume, is a direct act of assimilation, which the latter is not.*

* Since the above was written I have seen a paper by Dr. Wallich, in which he insists on the same thing. He says: "And let it be particularly borne in mind, as affording most conclusive testimony to the fact, that nutrition is effected in these two orders in the manner I have described; that is to say, not by the inception of already-formed organic products into the substance of the living protoplasm, but by a power inherent in that protoplasm, of converting inorganic elements into nutritive matter and shell tissue."—*Microscopical Journal*, April, 1869, p. 232.

Of the reproduction of the Protozoa but very little is known. In *Amœba* it is assumed that reproductive cells are produced, as also in *Arcella* and *Diffugia*. In the latter Mr. Carter has described, in the *Ann. Mag. Nat. History*, 1863, the mode of conjugation of *Diffugia pyriformis*, in which he observed the change of position of the chlorophyl cells, so that they became so "unequally divided that one test only contained one-fourth, and the other the remaining three-fourths of these organs." Now this is precisely what takes place in the lower forms of the Conferroid Algae, the Desmidiæ, &c., as observed by Mr. Carter, and also by myself many times. The only difference to be observed is, that in most of the Algae, on the conjugation of two fronds, the change of chlorophyl cells results generally in the production of a "sporangium." At the same time, something very analogous to this seems to take place in the production of the seed-like bodies in the fresh-water sponges, as these bodies are produced in the centre of a cluster of sponge-cells, or, in other words, in a group of sponge animals; and, so far as their chemical properties are concerned, it would be a very delicate test indeed, and an exceedingly clever manipulator that could separate the one from the other. The presence of starch grains, found in the vegetable kingdom, was considered for a very long time to be of sufficient importance to separate the two kingdoms; but this test is now abandoned as useless; for starch grains are found in abundance in the lower forms of the animal kingdom, and particularly in the animals composing the present group. Professor Williamson, in discussing the reproduction of the Rhizopoda, after mentioning the reproduction by fission and gemmation, in which case the young partake of any peculiarities the parent may possess, goes on to say, that "whether these germs were merely unimpregnated gemmiparous products, or whether they have resulted from the union of a germ-cell and a sperm-cell, cannot now be determined, though probably both these processes will ultimately be demonstrated to exist amongst Rhizopods." This then has been verified by Mr. Carter in the case of *Diffugia pyriformis*, as referred to above. Captain Jones, in his collecting and investigation of the Polycystina of the middle of the Indian and Atlantic oceans, observed the same mode of conjugation in these as seen in the Desmidiæ and the Diatomacea. He says: "I have seen the conjunction of two individuals, the yellow sarcode appearing on two separate yelks, one in each shell. One of my specimens shows the line of junction very distinctly, and, I think, proves that

such specimens must be taken as single individuals of another species." And in another he observed one shell filled with the sarcode, and the other quite empty. For a description of the reproduction of *Miliola*, as observed by Dujardin, see also Dr. Carpenter's *Introduction*, p. 37, Art. 49.

As a proof of any external peculiarity being transmitted from the parent Rhizopod through the young fissiparous bud or gemmæ, Professor Williamson remarks that a variety of Polymorphina prevails at Southport, in Lancashire, and also near the Eddystone Lighthouse and Plymouth Sound; and he says "that the study of the specimens, both from our own coasts and from foreign stations, satisfies me that there exists amongst the Foraminifera a strong tendency to the perpetuation of certain unvarying types of form." This being known, it shows at once the great difficulty of ascertaining what is a species and what is not; and this peculiarity may, and probably does, extend to higher forms in the animal kingdom—amongst the Mollusca, for instance; that many of those forms we have been in the habit of regarding as distinct species are probably after all only some deviation or peculiarity inherited by a race, and whose progenitors are lost in the lapse of time. At the same time this fixity of type would constitute, I presume, what we are in the habit of regarding as distinct species, although not a distinct creation.

The geographical distribution of the Foraminifera is of world-wide extent; and the marine forms are, so far as we know, of far greater abundance than those inhabiting the fresh waters. The marine forms are found from the littoral zone to the greatest depths yet sounded, either by lead or by dredge. The largest, and apparently the more highly developed, are found in the warmest seas; so that heat appears to affect these creatures in regard to a larger development of growth, if it does not affect the development of the animal structure. Amongst the fluviatile described we have twelve species, which does not appear many as compared with our ponds and streams; but still, as compared with other counties, I think we stand foremost in the rank at present. In marine forms we are, I think I may say, well represented, thanks to Mr. Spence Bate and Mr. Barlee. These gentlemen have contributed largely to our knowledge of those inhabiting our southern coast, as shown by the many times their names occur in Professor Williamson's beautiful *Monograph*. Of the 117 species or types and varieties figured and described by him, we have between 60 and 70 enumerated as obtained on our south coast. The principal localities are those of Exmouth,

Brixham, and Plymouth. But few, so far as I am aware, have been obtained on the north coast. There is, therefore, I believe, a good field open to the diligent investigator.

The enormous quantities of the shells of these animals met with on almost every part of the sea-bottom shows at once the important part they play in the order of creation; and, as Dr. Bigsby has well said, that "the simpler organization of the Protozoa and Diatomacea, but especially their extreme fecundity, enables them to resist successfully all the agents of extinction." And this gradually carries me to their distribution in time.

It has been argued by Dr. Carpenter and others, that the indefinite-looking fossil found in the Laurentian rocks of North America belongs to the Protozoa; and now, since the discovery of the *Bathybius*, previously mentioned as found covering the sea-bottom of the North Atlantic, between the Faroe Islands and the north of Scotland, this appears to me to confirm Dr. Carpenter's suggestion.

One can picture in the mind's-eye the masses of *Oozone Canadensis* spread over the bottom of the ancient sea in a similar manner to the *Bathybius* of the present time. At a later period, and upon the next horizon, Professor Ehrenberg proved to his own satisfaction that the green grains that are scattered through the sandstones of the Lower Silurian rocks of Russia contain in their interior the silicious casts of Foraminiferous shells, belonging to 14 genera and 17 species; but Professor Rupert Jones is inclined to doubt the accuracy of the above conclusion. He says: "There is not one of the above determinations that can be definitely accepted: some of the grains are possibly parts of *Oozone*." In the white carboniferous limestone of Russia the genus *Fusulina* is found in great abundance, and as we ascend the series of sedimentary deposits, and get nearer to our own time, the more numerous do the species and varieties become. The Lias and the Oolite each contribute their quota to the great mass; but when we arrive at the Chalk, here the great family of Foraminifera appears to have culminated; for it is to the innumerable multitudes of these organisms that we are indebted for those grand deposits of chalk which form the two white walls on each side of the British Channel.

Dr. Carpenter says, in speaking of the North Atlantic sea-bed, "that he is disposed to look on the cretaceous sea-bottom as the still existing chalk formation; and he thinks this view finds support in the fact that its basis is nearly the same as that cretaceous deposit, that certain shells are

common to both, and that Silicious sponges are extremely abundant."

In the Tertiary deposits are first seen the undoubted ancestors of the now existing forms; so that whether they be species according to the old accepted theory or not, they appear to have a fixity of distinction placed upon them which is certainly not obliterated by time.

A CATALOGUE OF THE PROTOZOA OF DEVONSHIRE.

WITH NOTES AND OBSERVATIONS.

BY EDWARD PARFITT.

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SUB-KINGDOM.

PROTOZOA, *Siebold*.

Class, RHIZOPODA.

Gen., AMOEBA.

PRINCEPS, *Ehr.*

t. 8, f. 10; *Carpén.* on the Micro., fig. 230; *Carter*, *Ann. Mag. Nat. Hist.*, 1863, vol. xii., p. 30, t. 3.

In a shallow ditch at Exwick, near the Dripping Rock;
 E. P. Railway ponds, Exminster marshes; Mr. Vicary.
 Budleigh Salterton; Mr. Carter.

VOL. III.

E

VILLOSA, Wallich.

Ann. M. N. H., 1863, p. 287, t. 8.

This very distinct species I met with gliding over the mud of a horse pond, near the farm at Polsloe, near Exeter, August, 1864.

Gen., **DIFFLUGIA**, Eht.

COMPRESSA, Carter.

In Ann. M. N. H., 1864, ser. 3rd, t. 1, f. 5, 6.

Taken at Budleigh Salterton, amongst confervoid algæ, in considerable numbers; Mr. Carter.

PYRIFORMIS, Perty.

Carter in Ann., 1864, t. 1, f. 1; see also Carter in Annals M. N. H., 1862, p. 249, *et seq.*

In fresh water drains, Budleigh Salterton, amongst decaying leaves, &c. I met with specimens at Exwick, near Exeter, in a shallow drain amongst decaying leaves.

PROTEIFORMIS, var. *Acuminata*, Wallich.

Ann. Nat. Hist., 1863, t. 10, f. 13.

I met with a single specimen of this in a shallow drain near the Wet Rock, Exwick, Exeter. The specimen differs very slightly in form from that figured by Dr. Wallich; but if any reliance can be placed on form in these creatures, the one I have in view must be referred to this. The form of the testa is like the one figured by Mr. Carter, Ann. Nat., s. 3, vol. xiii, t. 1, f. 11; but this figure is without the pointed or spinous process at the larger or globular end. In my specimen it was rounded and not acute, so that it would be intermediate—between the one figured by Dr. Wallich and Mr. Carter's.

URCEOLATA, Carter.

Ann. M. N. H., 1864, t. 1, fig. 7.

In heath-bog water, Budleigh Salterton.

PELTIGERACEA, Carter.

Ann. M. N. H., 1864, t. 1, f. 12.

Found about *Peltigera canina*, Tavistock; Mr. Carter.

SPIRALIS, Baily.

Carter in Ann. M. N. H., t. 1, f. 9.

In fresh water drains, Budleigh Salterton.

GEN., *ECHINOPYXIS*, *Clop et Lachm.*ACULEATA, *Ehr.**Carter* in Ann. M. N. H., 1864, t. 1, f. 8.

Common at Budleigh Salterton.

GEN., *ARCELLA*, *Ehr.*VULGARIS, *Ehr.**Carter* in Ann. M. N. H., 1864, t. ii., f. 14.

Budleigh Salterton; Mr. Carter.

GEN., *EUGLYPHA*, *Duj.*COMPRESSA, *Carter.*

In Ann. M. N. H., 1864, t. 1, f. 13.

In heath-bog water, Budleigh Salterton; apparently rare.

GEN., *CYPHODERIA*, *Schlumberger.*MAGARITACEA, *Schl.**Carter* in Ann. M. N. H., t. ii., f. 18.

Budleigh Salterton.

GEN., *ACTINOPHREYS*, *Ehr.*SOL, *Ehr.**Adams*, t. 25, f. 65, 66; *Carpén*, p. 458, f. 229.

In the Exeter Canal; not uncommon amongst conserva.

GEN., *ACANTHOCYSTES*, *Carter.*TURFACEA, *Carter.*

In Ann. M. N. H., 1863, p. 263; 1864, t. 2, f. 25.

In fresh water drains, Budleigh Salterton.

SECTION .

RHIZOPODA, FORAMINIFERA.

GEN., *ORBULINA*, *D'Orbigny.*UNIVERSA, *D'Orb.**Planci*, t. 2, fig. 4, D.E.F.; *Willm.* t. 1, f. 4.Taken at Brixham, and near the Eddystone Lighthouse;
Mr. Spence Bate.GEN., *LAGENA*, *Walker.*VULGARIS, *Planci.*t. 2, fig. 10, M.N.O.; *Willm.* t. 1, figs. 5-14, f. 5a, *typica*.

Taken in Plymouth Sound by Mr. Spence Bate.

b. Var. CLAVATA, Willm.

t. 1, f. 6.

Plymouth Sound and Eddystone; Mr. Spence Bate.

c. PERLUCIDA, Willm.

t. 1, figs. 7, 8.

Taken at Brixham, Plymouth, and near the Eddystone Lighthouse; Mr. Spence Bate. Exmouth; Mr. Kane.

d. SEMISTRIA, Willm.

t. 1, f. 9.

e. STRIATA, Willm.

t. 1, f. 10.

Exmouth; Mr. Kane. Plymouth Sound and Eddystone; Mr. Spence Bate.

f. INTERRUPTA, Willm.

t. 1, f. 11.

g. GRACILIS, Willm.

t. 1, figs. 12, 13.

h. SUBSTRIATA, Willm.

t. 1, f. 14.

Taken at Brixham, Exmouth.

GEN., *ENTOSOLENIA, Ehrenberg.**GLOBOSA, Walker.**Willm.* t. 1, figs. 15, 16.

Taken at Exmouth; Mr. Kane. Brixham; Mr. G. Barlee.

b. LINEATA, Willm.

t. 1, f. 17.

Exmouth; Mr. Kane. Brixham, Plymouth Sound; Mr. Spence Bate.

*MARGINATA, Walker.**Willm.* t. 1, figs. 19-21.

Taken at Exmouth by Mr. Kane.

b. LUCIDA, Willm.

t. 1, figs. 22, 23.

Plymouth Sound and Eddystone; Mr. Spence Bate.

c. ORNATA, Willm.

t. 1, f. 24.

d. LAGENOIDES, Willm.

t. 1, figs. 25, 26.

Taken at Brixham; Mr. G. Barlee. Plymouth Sound;
Mr. Spence Bate.*e. QUADRATA, Willm.*

t. 1, figs. 27, 28.

Taken at Brixham by Mr. G. Barlee.

*SQUAMOSA, Maton and Rackett.**Willm.* t. 1, f. 29.Taken at Exmouth; Mr. Kane. Brixham; Mr. G. Barlee,
Plymouth Sound; Mr. Spence Bate.GEN., *LINGULINA, D'Orbigny.**CARINATA, D'Orb.**Willm.* t. 2, figs. 33, 34, 35.

Taken in Plymouth Sound by Mr. Spence Bate; very rare.

GEN., *MODOSARIA, Lamarck.**RADICULA, Linnæus.**Willm.* t. 2, figs. 36-38.

Taken in Plymouth Sound; Mr. Spence Bate.

*PYRULA, D'Orb.**Willm.* t. 2, f. 39.Exmouth; Mr. W. Clark. Plymouth Sound; Mr. Spence
Bate.GEN., *DENTALINA, D'Orbigny.**SUBACUATA, Mont.*Test. Brit. t. 6, f. 5; *Willm.* t. 2, figs. 40-44.Taken at Exmouth by Mr. Kane. Plymouth Sound; Mr.
Spence Bate.*b. JUGOSA, Mont.*

Test. Brit. t. 14, f. 1.

*LEGUMEN, Linn.**Jani Planci*, t. 1, f. 7, whose figure is very good for the time; *Willm.*
t. 2, figs. 45-49.

Taken at Barnstaple by Mr. Jeffrey; Exmouth, Mr. Clark.

GEN., *CRISTELLARIA, Lamarck.**CALCAR, Linn.**Jani Planci*, t. 1, figs. 3, c, h, i; *Willm.* t. 2, figs. 52, 55.

Taken in Plymouth Sound by Mr. Spence Bate.

*b. ROTIFER, Linn.**Willm. t. 2, f. 54.**c. OBLONGA, Willm.**t. 2, f. 55.*SUBARCUATULA, *Walk.**Willm. t. 2, figs. 56, 57.*

Taken at Brixham by Mr. G. Barlee. Plymouth Sound
and near the Eddystone by Mr. Spence Bate.

GEN., *MONIONINA, D'Orbigny.*CRASSULA, *Walk.**Willm. t. 3, figs. 70, 71.*

Frequent along the south coast. In the washings of oysters
obtained off the south coast. It is the most common of
all the species I have met with.

JEFFREYSII, *Willm.**t. 3, figs. 72, 73.*

Taken at Exmouth by Mr. Barlee. Brixham, Torquay;
Mrs. Brett. Plymouth Sound; Mr. Spence Bate.

GEN., *NUMMULINA, D'Orbigny.*PLANULATA, *Lam.**Willm. t. 3, figs. 74, 75.*GEN., *POLYSTOMELLA, Lamarck.*CRISPA, *Linn.**J. Planci, t. 1, figs. 2, D, E, F; Willm. t. 3, figs. 78, 80.*

On oyster shells on the south coast; not common.

UMBILICATULA, *Walk.**Willm. t. 3, figs. 81, 82, 82a.*

Frequent along the coast. Exmouth; Mr. Kane. Torquay;
Mrs. Brett. Brixham, Plymouth Sound; Mr. Spence Bate.
I have taken it on oysters dredged off the south coast.

GEN., *PATELLENA, Williams.*CORRUGATA, *Willm.**t. 3, figs. 86-89.*

Taken at Brixham by Mr. G. Barlee.

GEN., *ROTALINA, D'Orbigny.*BECARII, *Lin.**Willm. t. 4, figs. 90-92.*

On oyster shells dredged off the south coast; frequent.

INFLATA, *Mont.*

Test. Brit. Supp. t. 18, f. 3; *Willm.* t. 4, figs. 93, 94.

Found amongst sand on the south coast; Col. Montagu. It appears to be very rare. I have taken it amongst washings of oysters obtained off our south coast.

OBLONGA, *Willm.*

t. 48, figs. 98-100.

Taken near the Eddystone by Mr. Spence Bate.

CONCAMERATA, *Mont.*

Test. Brit. Supp. p. 160; *Willm.* t. 4, f. 101, 105.

Col. Montagu says it is a rare species, taken up by *Amphitrite ventilabrum* in the construction of its tube. I have taken it on oysters dredged off the south coast.

NITIDA, *Willm.*

t. 4, figs. 106-108.

Taken in Plymouth Sound by Mr. Spence Bate. Brixham; Mr. Barlee. Torquay; Mrs. Brett.

MAMILLA, *Willm.*

t. 4, figs. 109-111.

Taken at Exmouth by Mr. Clarke, and at Torbay by Mr. J. G. Jeffreys.

FUSCA, *Willm.*

t. 5, figs. 114, 115.

Taken at Exmouth by Mr. Spence Bate and Mr. Barlee.

GEN., PLANORBULINA, *D'Orbigny.***MEDITERRANENSIS, *D'Orb.***

Willm. t. 5, figs. 119, 120.

Taken at Brixham by Mr. G. Barlee; Torbay by Mr. Jeffreys; Exmouth, Mr. Kane; Eddystone, Mr. Spence Bate—abundant.

GEN., GLOBIGERINA, *D'Orbigny.***BULLOIDES, *D'Orb.***

Willm. t. 5, figs. 116-118.

This is one of the most abundant species on our coast.

GEN., TRUNCATULINA, *D'Orbigny.***LOBATULA, *Walker.***

Willm. t. 5, figs. 121, 123.

Taken attached to *Sertularians* from the coralline zone along our coast; Col. Montagu.

GEN., *BULIMINA*, *D'Orbigny*.PUPOIDES, *D'Orbig.**Willm.* t. 5, figs. 124, 125.

Taken at Brixham, Torbay, and Plymouth Sound.

b. *MARGINATA*, *Willm.*

t. 5, figs. 126, 127.

Taken in Plymouth Sound and near the Eddystone by Mr. Spence Bate.

c. *SPINULOSA*, *Willm.*

t. 5, fig. 128.

d. *FUSIFORMIS*, *Willm.*

t. 5, figs. 129, 130.

Taken at Exmouth by Mr. Kane.

e. *ELONGATA*, *Willm.*

t. 5, f.

Taken in Plymouth Sound by Mr. Spence Bate; abundant.

ELEGANTISSIMA, *D'Orbig.**Willm.* t. 5, figs. 134, 135.

Taken in Torbay by Mrs. Brett. Brixham; Mr. G. Barlee-Exmouth; Mr. Kane.

SCABRA, *Willm.*

t. 5, figs. 136, 137.

Taken in Plymouth Sound by Mr. Spence Bate.

GEN., *UVIGERINA*, *D'Orbigny*.*ANGULOSA*, *Willm.*

t. 5, f. 140.

Taken in Torbay by Mrs. Brett.

GEN., *CASSIDULINA*, *D'Orbigny*.*OBTUSA*, *Willm.*

t. 6, figs. 143, 144.

Taken at Brixham by Mr. G. Barlee, and I obtained it on oysters dredged off the south coast.

GEN., *POLYMORPHINA*, *D'Orbigny*.*LACTEA*, *Adams*.Essays on the Microscope, t. 14, f. 4; *Willm.* t. 6, figs. 145-147.

Taken at Exmouth by Mr. Kane. Brixham; Mr. G. Barlee. Plymouth Sound; Mr. Spence Bate.

a. OBLONGA, Brown.

Conch. Illus. t. 56, figs. 16, 17.

Taken abundantly at Brixham by Mr. G. Barlee, and also at the Eddystone by Mr. Spence Bate.

e. CONCAVA, Willm.

t. 6, figs. 151, 152.

Obtained at Brixham by Mr. G. Barlee.

f. COMMUNIS, D'Orbig.

Parker and Jones, Ann. M. N. H. 2nd ser., t. 10, figs. 25, 26, 27; Willm. t. 6, figs. 153, 155.

Taken at Brixham—plentiful—by Mr. G. Barlee. Plymouth Sound and Eddystone by Mr. Spence Bate.

MYRISTIFORMIS, Willm.

t. 6, figs. 156, 157.

Taken off the Eddystone by Mr. Spence Bate.

GEN., *TEXTULARIA, DeFrance.**CUNEIFORMIS, D'Orbig.*

Willm. t. 6, figs. 158, 159.

Taken at Brixham by Mr. G. Barlee; Torbay by Mr. Jeffrey, Exmouth; Plymouth Sound by Mr. Spence Bate.

VARIABILIS, Willm.

t. 6, figs. 162, 163 (this is numbered 161 in the plate).

Taken at Torbay by Mrs. Brett, and Brixham by Mr. G. Barlee; Plymouth Sound, Mr. Spence Bate; Exmouth, Mr. Kane.

b. SPATULATA, Willm.

t. 6, figs. 164, 165.

Taken at Torquay by Mrs. Brett.

d. LÆVIGATA, Willm.

t. 6, f. 168.

Obtained at Brixham by Mr. G. Barlee.

GEN., *BILOCULINA, D'Orbigny.**RINGENS, D'Orbig.*

Willms. t. 6a, figs. 169, 176.

Taken at Exmouth by Mr. Clarke; Plymouth and Eddystone by Mr. Spence Bate.

*b. CARINATA, D'Orbig.**Willms. t. 7, figs. 172, 174.*

Taken at Exmouth by Mr. Clarke; Plymouth Sound and
Eddystone by Mr. Spence Bate.

GEN., *SPIROLOGULINA, D'Orbigny.*

*DEPRESSA, D'Orbig.**Willms. t. 7, f. 177.*

Exmouth; Mr. Clarke.

*b. ROTUNDA, D'Orbig.**Willms. t. 7, f. 178.*

Taken at Exmouth.

GEN., *MILIOLINA, Williams.*

*TRIGONULA, Lam.**Willms. t. 7, figs. 180-182.*

Taken at Brixham by Mr. G. Barlea. Plymouth Sound;
Mr. Spence Bate. Torbay; Mr. Jeffreys.

*SEMINULUM, Linn.**Willms. t. 7, figs. 183-189.*

Taken in sand, Salcombe Bay; and in shell sand, Torbay.

*b. OBLONGA, Mont.**Test. Brit. vol. ii. t. 14, f. 9; Willms. t. 7, figs. 186, 187.*

Taken in sand, Salcombe Bay, Brixham, &c,

*c. DISCIFORMIS, MacGill.**Willms. t. 7, figs. 188, 189.*

In shell sand, Torbay; $\frac{1}{80}$ long, $\frac{1}{80}$ in diameter. My speci-
mens are not so strongly marked or folded as those
figured by Mr. Wilkinson.

*BICORNIS, Walk.**Adams' Essays on Micros. t. 14, f. 2; Willms. t. 7, figs. 190, 198.*

GEN., *SPIRILLINA, Ehrenberg.*

*FOLIACEA, Phillips.**Willms. t. 7, figs. 199, 201.*

Taken at Brixham, Torbay, and in Plymouth Sound.

*PERFORATA, Schultz.**Ehreb. Verbrät. t. 3, f. 441; Willms. t. 7, f. 202.*

Taken by Mr. Jeffrey at Torbay.

ON THE MINERAL LOCALITIES OF DEVONSHIRE.

PART II.

BY TOWNSHEND M. HALL, F.G.S., ETC.

SINCE the publication of my catalogue in the Transactions of this Association for 1868, the occurrence of a few more minerals in this county has been brought before my notice; and in order to make the summary of our Devonshire species as complete as possible, it has been suggested that I should take this opportunity of adding to the former list the several observations which have been collected during the course of the last twelve months.

At the same time I would wish to draw attention to a subject which is intimately connected with mineralogy, although it may, perhaps, be thought to belong more properly to another branch of scientific investigation. I allude to an *aërolite* which descended in South Devon in the year 1623, and which is, I believe, the earliest recorded instance of this phenomenon in Great Britain. No portion of it is at present supposed to be in existence; but to those who know the care and veneration with which meteoric stones have almost universally been preserved, and how they were in former times either handed down from one generation to another, or else deposited for safety in some neighbouring church,* it will not be thought too much to say, that even now there may be a possibility of recovering it.

After the lapse of nearly two centuries and a half it may be objected, that to re-discover a fragment of stone would be next to impossible; but meteoric iron is, fortunately, a substance which may be easily recognised, and which at the same time is almost indestructible. Even in the case of the *aërolite* of *Ægos Potamos*, which fell in the year 467 B.C., the eminent Humbolt appears never to have relinquished the hope that it might be found again by some traveller, although

* For example, the meteorites preserved at Elbogen in Bohemia, Ensisheim in Alsace, and many others.

it had been totally lost sight of for more than eighteen centuries.*

To succeed in tracing any portion, however small, of the Devonshire meteorite would prove a most important and valuable discovery; and those members of the Association who reside in the Southern Division of the county may, by searching amongst ancient records, or by making enquiries from representatives of old established families, succeed in obtaining some clue which would lead to the desired result.

In a note at the end of this paper will be found references to old Devonshire historians, who appear to have described with considerable minuteness the exact locality in which the meteorite descended.

ADDENDA TO THE CATALOGUE OF DEVONSHIRE MINERALS.

CLASS I. METALLIC MINERALS.

COPPER.

SULPHURET OF COPPER.

Redruthite, Copper Glance, or Vitreous Copper. Although abundant in Cornwall, the occurrence of vitreous copper in Devonshire does not appear to have been noted. I have, however, lately received from Mr. W. J. Henwood, F.R.S., a letter, informing me that it has been found both at Huel Friendship, near Tavistock, and at Bottle Hill, near Plympton. In some of the other mines in the neighbourhood of Tavistock Redruthite would probably also be found.

OXIDE OF COPPER.

Melaconite, or Black Copper. This species probably results from the decomposition of other ores of copper, such as Bornite, Redruthite, and Towanite. It occurs at Huel Friendship, near Tavistock, &c.

NOTE.—Since the above was communicated to the association I have received, through the kindness of Mr. Joseph Matthews, of Tavistock, two specimens of Melaconite from the Devon Great Consols. At the same time Mr. Matthews informed me that both the grey and black ores of copper had been obtained fifteen or twenty years ago in the following mines, all of which are situated in the neighbourhood of Tavistock:—Devon Great Consols, Huel Friendship, East Huel Russell, and Bedford Consols.

* "Cosmos," vol. i. p. 103, and "Popular Science Review," vol. v. p. 408.

CLASS II. NON-METALLIC MINERALS.

LIME.

SILICATE OF LIME AND IRON.

Babingtonite. This species has recently been identified as an English mineral; perfectly authentic specimens having hitherto only been obtained from Arendal, in Norway.

In 1854 a mineral which had been found in such quantities as to be used extensively as an iron ore, was sent by the late Mr. S. Blackwell to Mr. David Forbes, F.R.S., with the request that he would assay it for iron. The sample was found to contain 20·24 per cent. of iron, and a large proportion of silica; but Mr. Forbes has only lately been able to make a more complete analysis, which has resulted in showing that the Devonshire specimen was identical in composition with the Babingtonite of Norway.

The mineral much resembles hornblende in appearance, and "occurs as an aggregate of groups of radiating crystalline fibres, which curve in towards their centres of development, and possess a decided dark, blackish-green colour. Its lustre is vitreous, and in very thin splinters it is translucent."*

MAGNESIA.

MAGNESIA, LIME, AND IRON, SILICATE OF.

Asbestos. With reference to my notice of the occurrence of this mineral near Seaton,† I am informed by the Rev. R. Kirwan that it is also found, though rarely, at Sidmouth, where it is popularly known by the name of "petrified leather." In the Seaton cliffs it is not uncommon.

SODIUM.

CARBONATE OF SODA.

Natron. At the church of Stoke St. Nectan, Hartland, the internal walls of the tower are in many places corroded by carbonate of soda, which attacks certain stones, and beginning from the surface eats out in the course of time holes to a depth of three or four inches, depositing in the cavity a thin efflorescent crust. This on exposure to the atmosphere speedily falls into powder. It may be remarked that those parts only of the stone which are in contact with the mortar appear to be proof against the action of decay. The carbonate of soda is not to be found in any other part of the walls of the church, nor does it appear to affect the stonework of any of the houses in the neighbourhood.

* "Philosophical Magazine," May, 1869.

† Transactions of the Devon Association, vol. ii. p. 344.

CHLORIDE OF SODIUM.

Salt. Pseudomorphous crystals of chloride of sodium have been noticed by Mr. Ormerod as occurring "in a shallow cutting by the side of the Taunton and Ilminster turnpike-road, near Blackbrook," and also associated "with the water-stone beds in the face of the cliff between Sidmouth and Salcombe mouth."*

 ADDITIONAL NOTE RESPECTING THE DEVONSHIRE METEORITE.

THE earliest meteoric stone recorded as having fallen in Great Britain descended near Sir George Chudleigh's house, at Stretchleigh, in the parish of Ermington, about 12 miles from Plymouth. The circumstance is thus related by Westcote: "In some part of this manor (Stretchleigh) there fell from above—I cannot say from heaven—a stone of twenty-three pounds weight, with a great and fearful noise in falling. First it was heard like unto thunder, or rather to be thought the report of some great ordnance, cannon, or culverin; and as it descended so did the noise lessen, at last, when it came to the earth, to the height of the report of a petronel, or pistol. It was for matter like unto a stone singed, or half burnt for lime; but being larger described by a richer wit, I will forbear to enlarge on it."

The "richer wit" here alluded to was in all probability the author of a pamphlet published at the time, which further describes this *aërolite* as having fallen on January 10th, 1623, in an orchard, near some men who were planting trees. It was buried in the ground three feet deep, and its dimensions were $3\frac{1}{2}$ feet long, $2\frac{1}{2}$ wide, and $1\frac{1}{2}$ thick. The pamphlet also states that pieces broken from off it were in the possession of many of the neighbouring gentry.†

In *Risdon's Survey of Devon* the fall of the meteorite is described in very much the same words as those used by Westcote: "In this seigniory, (Stretchleigh,) A.D. 1623, there fell from above a stone of twenty-three pounds weight, which in falling made a fearful noise, first like the rumbling of a piece of ordnance, which in descending lower lessened, and ended, when upon the ground, no louder than the report of a petronel. It was composed of matter like a stone singed, or half burnt for lime."

* "Transactions of the Devonshire Association," vol. ii. p. 384.

† "Popular Science Review," vol. v. p. 409. See also Lysons' "Magna Britannia."

NOTICE OF MOLARS OF HIPPOPOTAMUS MAJOR STATED TO HAVE BEEN FOUND IN KENT'S CAVERN, TORQUAY.

BY G. WARKING ORMEROD, M.A., F.G.S.

THE teeth which are now noticed are the first and last molars of the Hippopotamus Major, and the earth with which they are partially encrusted shows that they were procured from a cavern. They were purchased by myself at the shop of Mr. Sclater, at Teignmouth, a dealer in objects of natural history, who informed me that they had been a long time in the possession of himself and his father, who had purchased them at the sale of Mr. Langley's effects, and that Mr. Langley had received them from Mr. MacEnery. In the *Literature of Kent's Cavern prior to 1859*, by Mr. Pengelly,* a letter from Mr. Northmore is printed, which mentions that in 1824 the remains of the Hippopotamus had been there discovered. Mr. Pidsley, of Newton Abbot, informs me that at the sale of MacEnery's collection the Hippopotamus' remains were catalogued and sold as coming from Kent's Cavern. The specimens were not marked as coming from Kent's Cavern by MacEnery, but at that time (about 1841) it was presumed that such was the case by the person who prepared the catalogue, and the point was not questioned.

Professor Owen, in the *British Fossil Mammals* (1846), writes (page 410), that "remains of the extinct Hippopotamus have been found in other limestone caves in England than that of Kirkdale; as for example at Kent's Hole, Torquay." The bones from Kent's Hole were, he states (page ix in Introduction), in the mineralogical department of the British Museum, and were obtained at the sale of the collection of the late Mr. MacEnery.

The reports presented to the British Association by the committee for exploring Kent's Cavern state the various remains that have been found, but those of the Hippopotamus Major do not occur in the lists. Mr. Pengelly also informs me that he has not found any notice of the remains of this animal in MacEnery's papers.

Thus we have the clear statement of Mr. Northmore that

* "Transactions of the Devonshire Association," vol. ii. p. 48.

in 1824 Hippopotamus bones had been found in this cave; at the sale of MacEnery's collection they were sold unquestioned as coming from the cave; and so they have been regarded by the authorities at the British Museum. On the other hand, no bones of this animal have been found during the present examination, and they are not mentioned in MacEnery's papers. On one side we have statements that they *have* been found; on the other side no notice of their existence is met with. Taking the question on this evidence, the presumption would, of course, be that Hippopotamus' bones had been found; but as MacEnery does not name them as occurring in the cavern, as the specimens sold in his collection were not labelled by him as coming from the cavern, and as no remains of a similar nature are now found, I think that it would not be proper to enter the remains of the Hippopotamus Major on the list of those undoubtedly occurring in the cavern, but that it should be stated that this point was questionable.

NOTICE OF THE OCCURRENCE OF SCAPOLITE AT CHAGFORD, DEVON.

BY G. WAREING ORMEROD, M.A., F.G.S.

THE mineral Scapolite, known also as "Wernerite," "Meionite," and "Pyramidal Elain Spar," is found, as mentioned by Phillips and Nicol in their respective mineralogies, in Finland, Sweden, East Scotland, Greenland, Vesuvius, and Massachusetts. Phillips also writes that it occurs in primitive mountains, and in the gneiss at the iron mines of Arendal, in Norway. Gregg and Letsome's *Mineralogy of the British Isles and Ireland* does not notice the mineral. "Scapolite" is a combination consisting mostly of silica, alumina, lime, and soda, but very variable in composition. The specimen exhibited formed part of a mass about the size of the palm of a hand, and was found by myself last autumn to the south of the village of Chagford, in a narrow vein in the granite, composed for the most part of felspar, schorl, and quartz in crystals, and small patches of calcedony. There is no specimen from Great Britain either in the British Museum or in the museum in Jermyn Street. I believe that this mineral has not been hitherto noticed as occurring in Devon; I doubt if it has been noticed as occurring in Great Britain; and therefore thought it right to lay this first notice of its discovery before this society.

STATISTICS SOCIAL AND SCIENTIFIC.

BY SIR J. BOWRING, LL.D., F.R.S.

THE current and popular objection against statistics is their unsatisfactory and uncertain character—that they are incomplete, one-sided, badly grouped, irrelevant, or untrustworthy. These, no doubt, are the vices of statistical tables; and if they possess any of these defective qualities, or are wanting in the contrasted excellencies, their value will be diminished or destroyed, elevated or maximized, by the absence or the presence of the needful evidence of trustworthiness.

But for the very reason that *bad* statistics ought to be condemned and rejected on account of their deficiencies, *good* statistics should be welcomed and valued according to their completeness.

The perfection of a statistical table would consist in its being exhaustive; in other words, that no element connected with the topic in question should be omitted. In all good accountancy this is a *sine quâ non*, and the absence of a single figure might disturb the whole result. In order to give statistics an exhaustive character, the field of observation should be accurately defined, and its boundaries well laid down. If statistical returns omit any one element necessary to the elucidation of the object under discussion, it is as detrimental to their value as if they were burthened with irrelevant and superfluous matter.

Correct statistics are indeed the only solid foundation on which appropriate legislation can be built up; and it is as important to the lawgiver that they should be safe and sound, as to the architect that an edifice should have a stable basis.

All scientific problems have for their main object and noblest result, to help our knowledge of the great laws which govern the universe, and their value consists in the certainty of the facts which they are able to establish. And in the vast area which is opened to statistical investigation, the real

value of the facts and figures which are brought together is to be tested by their throwing light upon the great laws—social, political, and economical—by which society is or ought to be governed.

In the progress of time, statistics, over a large part of the field of observation, will become nearly as reliable as the records of an almanack, or the results of an arithmetical sum. Provide a sufficient machinery, and the population returns might be made perfect for all practical ends. There is no reason that every birth, marriage, and death should not be accurately noted. Vital statistics will be unsatisfactory when they go into very diffuse details; as for example when they undertake to report the exact length of life of every individual, the cause of death, or any particulars where opinion is to stand in the place of substantive fact.

Statistics, and their application to the business of life, bear the same relation to each other as knowledge does to wisdom, or evidence to conclusions. There may be an accurate acquaintance with facts, yet the deductions drawn may be erroneous; while there may be very sound reasoning, though the elements may be imperfect or unsatisfactory. From a narrow field of observation truths may be elicited applicable to a much wider area. In the mind of a Newton, the fall of an apple sufficed to establish the universal law by which the solar system and all the machinery of heaven are guided.

The facts which statistics record, or seek to record, are really as much regulated by universal law as are the changes of the seasons, or the revolving of the planets round the sun. The phenomena of life and death, the relation between supply and demand, the influences of capital upon labour and of labour upon capital, and all the seemingly intricate questions of political economy, furnish materials for arithmetical and mathematical results which will be found to harmonize with and to be controlled by some permanent law.

The statistics of geology are alarming from their magnitude. Dr. Darwin estimates that the denudation of the weald of Kent, proceeding at the rate of one inch per century, would require a period of 306,662,400 years. The weald extends only for 22 miles, with a thickness of 1100 feet. The thickness of the Tertiary strata is estimated at 2200 feet; that of the Secondary strata at 13,190 feet; that of the Paleozoic 57,154 feet. Here indeed we are launched upon an ocean of figures, the contemplation of which may well stagger the imagination, and almost defy the power of calculation. It would be a step towards simplification, and for avoiding a redundancy of

figures, if the Buddhistic Kalpa of 10,000 years were adopted as the geological and astronomical unit.

How feeble, indeed how necessarily imperfect, is the power of statistics when we launch into the infinities of space and time! And how eagerly, but almost hopelessly, can we anticipate the days when they will help to sober the questionings of advanced philosophy, and throw their light upon the dimness and the darkness of unexplored distances and of remotest ages! Yet may not a time arrive in which arithmetic shall enable us to calculate with thorough accuracy the remoteness of stars and planets, their relations and dependence on one another, their orbits and their aberrations, if such there be, but with our distinct knowledge that there is no aberration which is not subject to universal law; for happily enlightened science has brought us to this conclusion. Astronomy no doubt has led us into a world of light; but *this* we know, feel, and well may rejoice in the knowledge, the conviction, that far intenser light will be vouchsafed to future generations. Who knows, since discovery has already taught us of what the atmosphere is composed, of those wandering orbs, that we may not in time learn more of their substance as well as their shape, and of the living creatures that dwell upon their surface? Into what an area of observation will investigations be launched!—investigations as to what must be the conditions of vitality in all the varieties of heat and light in regions, to form an idea of whose remoteness arithmetic is scarcely able to furnish figures! And then in the eons of unconceivable centuries may we not be allowed to trace the origin and development of species through all its conditions from the monad to the man, and from man as he was when first—the unclad, the unhoused, the unprotected savage—dwelling in the tropical period with wandering elephants or with more redoubtable tigers and hyenas in their common caves, warring with and probably feeding upon one another? or in the glacial era, when with less to fear, his companions were reindeer and seals, of races now extinct? What a glory will it be if the *when* and the *how* shall be ascertained to accompany the now mysterious progress and development of the past, the present, and the future! when that “endless progress and perfection” of which Bacon speaks shall be unveiled so as to satisfy anxious and enlightened enquiry, if indeed such enquiry can ever be satisfied. It may be that something—much, may remain for ever unapproachable. There is that in the past, and there will be that in the future, which can only be reached by infinite wisdom and infinite power—whether, as the Buddhists

say, man, purified by the discipline of millions of ages, will at last be absorbed in and become a portion of the Deity, may become a question of speculation. In the thought itself there is a charm and a beauty, whose attractions will not be diminished by another Buddhistical fancy, that as everything was born in purity and loveliness, so it is destined to return to its primitive condition.

How utterly whelmed we are when we seek appropriate imagery to define what has been well called "the language of light;" and what but statistics can enable us to form any conception of those spaces, those distances, those orbs, respecting whose course and whose composition every day is furnishing us with new and marvellous information. The spectrum leads already into what appear regions of infinity; but as the poet has painted

"Beneath the lowest deep a lower deep,"

so the philosopher seems to be raised up from one infinite into another infinite beyond it. It was thought that it would be a grand discovery if an instrument could be found to reveal the presence of the thousandth part of a grain of sodium in a given flame; but analysis can now detect the presence of the hundred and eighty millionth part of a grain. Already we begin to know in what respects the composition of the rolling orbs of heaven agree and in what they differ from that of our own earth. Mr. Henderson has been enquiring into the remoteness of the fixed (but erroneously called *fixed*) star (α Centaur), and tells us it is 225,920 times as great as that of the sun, while that of Sirius is 896,804 as great. Fixed was, I said, an erroneous term; for it now appears, from Mr. Henderson's investigation, that Sirius is wandering away from the earth at the rate of a thousand millions of miles in the year. If revelations still more wondrous are wanting, consult Professor Roscoe's *Spectrum Analysis*.

The experience of the past may give us much encouragement as to the future. In the controversy between those who "number high intellects," it would be confessed that the men who have argued that the seeming convulsions of nature are as much a part of the general law as are the courses of the planets, or the progress of the seasons, have been the representatives of "the highest" intellectuality among the "high intellects,"—that the question whether man is not the result of organization far inferior to man can no longer be treated with scorn and indifference—that, without believing that our race is descended from chimpanzees or

apes, there is nothing degrading in the supposition that we are a great improvement on our progenitors, and that our descendants may, physically and intellectually, be superior to ourselves—that, in fact, man may grow to what angels are fancied to be in the mythology of creeds, and that truth may germinate from the seeds of error.

If the wolf or wild dog, under the influence of civilization and domestication, was the parent-stock of all the marvellous varieties of the canine species—so different in form, so unlike in habits; if the wild crab or sloe were the originals of all the apples and plums which adorn our tables or gratify our palates; if, to use the words of Professor Owen, “the most perfect and beautiful of quadrupeds, predestined and prepared for the use of man,” is the descendant of ruder animal forms, which have grown with man’s growth and strengthened with his strength; if the wild rose was the progenitor of the multiform, multi-coloured, and multi-perfumed children of the parental stock,—why should not man, with his boundless capacities, grow in graces and in glories? What anticipation of “things to be” is there not in that inquiry of the great teacher,—If God so clothe the grass of the field, whom all the glory of Solomon in his external adornings could not approach, shall He not provide even for us, the “men of little faith,” still better and brighter apparel? Shall the garments we are to wear hereafter in heaven not be more resplendent than those which have decorated our meaner persons on earth?

Connected with the progress of man, attention has been called to the progress of language from the rudest to the most cultivated:—idioms there are, which have only eight—that is to say, three vowel and five consonant sounds—and in which the whole number of words does not exceed about one hundred and twenty. Such idioms have no expressions which designate moral qualities, though they will have words which convey the sense of pain or pleasure; of colour they will have the light and the dark—invariably a word for blue, synonymous with the *sky*; and for green the representation of fields and forests; of numerals some have only two words, and they employ for larger numbers—“leaves,” “stars,” “sands.” What has this to do with statistics, it may be asked? Why statistics may enable us to prove the progress of language from the hundred words needful to the solitary groups of savages through the four or five hundred which Max. Müller says, form the whole vocabulary of the unlearned peasant, up to the six hundred thousand which would

be necessary to give separate designations to animals, insects, fruits, flowers, and other existing things, which are now the objects of investigation in the different departments of science.

Then again to enquire how many separate and distinct idioms formerly existed and now exist, how many have wholly disappeared with the races that employed them and when, how many have come down from antiquity or have been created by the fusion of various elements, as in our present English tongue. It will be probably found that the tendency of civilization is to diminish the number of languages; that the same process by which, as in France the Gascon, the Provençal, the Basque, and other dialects have been driven out by classical French,—as in Germany the many local dialects have been superseded by the Saxon, to which Luther's translation of the Bible so essentially contributed,—as in Spain the Euscará, the Galician, the Catalan, and the Valencian are giving way to the Castilian,—so throughout the whole world the languages spoken by the few are replaced by the richer and more useful language spoken by the many. And the time may be anticipated when the knowledge of a few languages will enable a man to communicate with the whole of his race, of every clime and colour. The statistician will be asking for the *when*, for figures, and dates, and calculations; the more speculative philosopher will busy himself with the *how*; but each will assist the other in his enquiries.

The Teutonic, with its German and Scandinavian branches,—the English—the Latin derived languages, like Spanish, Portuguese, Italian, and French—and the various forms of the Slavonic—may even now be said almost to monopolize the European area; and it would require no great amount of study to obtain a tolerable mastery of every language popularly spoken in every capital from Lisbon to Petersburg. And these changes are far more rapid than might be supposed. Of the principal languages of Europe there is not one that would be intelligible to an individual who lived seven or eight centuries ago. Who of us could hold a conversation with our Saxon ancestors? What would a Saxon of the time of the heptarchy make of the classical language of our modern historians? Literature no doubt stamps with less delible marks the progress of mind; and though we doubt not that ever augmenting riches will grace the tongues of our descendants, it is quite possible “the pure well of English undefiled” will hereafter receive great increase.

Among the evidences of the association of the highest

imaginative powers with the sobriety of philosophical enquiry, one may point out many of the verses of the poet laureate as striking examples. There are statistics in that fine thought that

"Millions of ages have gone to the making of man ;"

and the *In Memoriam* contains many charming specimens of the wedding of "divine philosophy—not harsh and rugged, as dull fools suppose, but musical as is Apollo's lute," with the most eloquent outpourings of the muse. Tennyson is the only modern poet (Gothe excepted) whose conceptions have been raised to the high standard of philosophical attainment, and in this respect his merits have never been adequately appreciated or recognised. It will be for the future to pay a becoming tribute to a great "singer," who has gone before his age in the elevation of his strains.

The poet dreams, that

"Though the great ages heave the hill,
And break the shore, and evermore
Make and break and work their will—
Though world on world in myriad myriads roll
Round us, each with different powers,
And other forms of life than ours,"

the statistician comes to the aid of the philosopher, calculates the distance each from each of these "great ages," when the shores are invaded, the hills raised, and the forms of life are developed from one to another.

Look, again, at the work of destruction,—how birds prey upon insects, and animals and carnivorous birds prey upon animals—how man preys upon man. Do the consequences of war, of shipwrecks, of what are called the accidents of life, remove from the human family numbers proportionate to those destroyed by instinctive impulses? Is there any law, or is it by anything but law, that plagues, diseases, and circumstances which interfere with the natural causes of death, keep the world from such an overflow of mankind as might prevent their finding proper nourishment for their own and family wants? What provides for the equality of the sexes when the consumption of *males*—their abstraction as soldiers, sailors, or for other occupations confined to the stronger sex—so interfere with that equality? Here vital statistics come to our aid, and, approximately at least, teach us *Rerum cognoscere causas*. But what instructive "causes" they must be, and how worthy of study, which have increased and are still increasing the average value or length of life!

Have all the results been pointed out which may be drawn from the tables of vital statistics, collected with so much care and so extensively circulated for the guidance of the legislator and the guidance of the people? What have been the consequences of polygamy among Oriental nations? What of monastic institutions? What of the celibacy of man or woman? How far does climate affect population? What is the action of emigration among nations abandoned by natives, and among nations among whom the emigrants settle? Are there laws which regulate the extinction of the less civilized or wholly savage man? Will the red man of North America, the aboriginal brown races of the Indian Archipelago, the negritos of the Philippines, disappear from the surface of the earth, and when? For certain it is that there is a paramount law which everywhere gives superiority and sovereignty to civilization whenever it comes into contact with comparative barbarism. Let America, let Asia, let Africa, even Europe, all tell their respective tales.

The fact that all the course of things is regular progression; that Nature does nothing by leaps; that if at times the onward march seems more perceptible than at other times, these aberrations are but part of the general law of order; all these considerations give to statistical enquiries a more firm and assured character. If, as in the case of Babbage's calculating machines, even arithmetical calculations seem lost in some remote, unintelligible, or at least unexplained inaccuracy, the aberration will interfere little with the general correctness of the figures. It is here as everywhere that the human faculties are bounded. Sounds there are unreached by mortal ears; visions around, about, below, far removed from the reach of mortal eyes; odours of which our feeble natural powers have no conception; not to speak of the weaker capacities of touch which extend to nothing far removed. It was a pretty fancy of Sir Humphrey Davey's, that a time might arrive when we should touch what is now remote, see what is now invisible, hear what is now inaudible; in a word, that all the senses might be enlarged and diffused. As to the where and the how conjecture may amuse itself by filling up the blanks. The suggestion was worthy of the noblest highest, and farthest-sighted philosophy.

Again, what are the laws which limit the increase of population? what those which provide for the natural increase? Was not Malthus right in his enunciation of the law, and wrong in supposing that anything was required on the part of man to give effect to the laws ordained by the Creator of

man? In this world is not man necessarily, and by his very nature, the power which gives effect to the law emanating from the Supreme Legislator? And is not his nature in itself a necessity? How can a universal law accommodate itself to special conditions? Then after all is the old question—not solved, we are told, by celestial philosophy—the strife between liberty and necessity, free will and fate. Are they irreconcilable? That cannot be. Is it possible to gather together the ingredients of both, give to them an arithmetical value, weigh them in the statistical scale? If not, why not? Here, as everywhere, we are driven upon the same solution—the solution of every difficulty—law is everywhere, and in everything; the same law in the beginning, in the progress, and in the end of things. Its power is not within the compass of figures; it is as irresistible as it is incalculable. The consolation is, that wherever power is infinite, wisdom and beneficence are everywhere without bounds. Statistics are feeble in the presence of the illimitable.

Why, again, and what is the law by which natural productions, however multitudinous, are checked? Of the millions of eggs that are deposited by the hen, how few produce chicken. The necessities of man in the care of domestic fowls, the disposition to destruction in the case of wild animals, present the needful control; but of the ova of the fly, the sperm of the fish, the feathered seeds of the thistle, what but some controlling power prevents the generation, so as to check the nuisance of a superabundant intrusion! Can any calculation be made of the numbers which fructify compared with those which perish? At what stage of production is the superabundance checked? It is checked, perhaps by the action of ordinary causes, perhaps by some unusual pestilence or endemic. It has to be checked, in the great interests of all, and the check is provided.

If the speculations of astronomy and geology, infinite in extent as they seem to be, are gathered into the regions of arithmetical calculation, not less are the phenomena of life, descending into the limitless depths of microscopical observation, destined to be brought into the statistical area. The millions of animated beings which dwell in a drop of water, or feed upon the covering of a fly, will be subject to calculations, like the pollen of a flower, the roe of a herring, the distance, magnitude, or number of heavenly bodies, or the processes by which all that is has been brought down from all that was, in the grand continuity whose origin is untraceable. Professor Huxley feels, as every one, the use, not to

say the necessity, of employing figures to present points of distance, or notions of extent. In these days we give a wider range to those conclusions, which appeared mysterious to the half-instructed, and were utterly unintelligible to the vulgar. Such as the great truth, that everything is in everything; which is, in fact, but to say, that there is an all-controlling influence, a common law, which some call providence, and others fate, which holds in subjection all space, all time, and whatever belongs to either. Happily to every being is given a work to do, a purpose to fulfil; and the succession of human beings, generation after generation, are but some of the multitudinous instruments for effecting the great but irresistible result.

On every side we see among investigators of science a disposition to give more distinctness to facts or to hypotheses by associating them with figures. Mr. Scott Moore, for example, suggests that the Lower Miocene epoch commenced about 10,000,000 years ago, the Upper Miocene about 825,000 years ago. The Upper Miocene blended with the Pliocene about 675,000 years ago, and the Pliocene with the Post-Pliocene about 350,000 years ago. The Glacial period crept on about 350,000 years since, and lasted for 270,000 to 280,000 years. Then the Penultimate era succeeded, about 50,000 years, and the most recent period, the supposed date of Adam's birth, 6,000 years since. To man he gives an origin of 350,000 years, if anterior to the Glacial epoch; if posterior to the Glacial period he may have a retrospective existence of from 70,000 to 80,000 years. Other theories will present themselves for investigation.

And ought not statistics to become a valuable auxiliary to the various departments of the public service? All the tendencies of science are to render their appliances more efficient and less costly. The waste of money in every branch of expenditure, whether from ignorance, indifference, or inaptitude, is so little a matter of discussion, that everybody seems to agree that improvements ought to be introduced, and less perfect works abandoned. The science of war has been wonderfully modified and changed by the discoveries of science, in the quiet regions of pacific thought. All that represents ignorance is waste; what knowledge brings is saving. The *stare super antiquas vias*—the obstinate determination not to enquire as to the *quo eundum*, but only into the *quo itur*. The old Baroman obstinacy, *Non volumus Leges Angliæ mutari*, the miserable plea that we do not want to be wiser than our forefathers—that plea to which the great

empire of China owes her stationary, unprogressive character—is happily superseded by the fact, that laws are constantly changed, in order to accommodate themselves to new social conditions and requirements; that we have learnt we are the oldest, because we are the last, of the generations of men; that we are bound to add to the knowledge of our forefathers the knowledge we have acquired; while we have the assured certainty that our descendants will be much more knowing than we. For to what unexplored regions future enquiry may penetrate remains yet to be disclosed; but of this we may feel secure, that there is no more evidence of profound knowledge than the confession, that after all we know but little.

Casting but a glance over the Parliamentary Returns for the last ten years, the results are most consolatory and encouraging for the greater extension of the principles and the policy which have prevailed in this latest decade of years.

While there has been a reduction of taxes to the amount of £9,486,515, or nearly a million a year, the revenue receipts for 1869 exceed by a million and a half those of 1860. Perhaps the most interesting fact is, the augmentation of the post-office receipts, under the penny postage system, from £3,310,000 to £4,660,000. The public debt has been diminished to the extent of £22,218,243. The imports, £2,493,843,682, being on an average £250,000,000 per annum, have increased from £179,182,355 in 1859, to £295,511,566 in 1869. The exports, £1,966,665,431, or about £20,000,000 per annum, have increased from £155,692,975 in 1859, to £227,588,663 in 1868. And the total value of our imports and exports has increased from £334,875,330 in 1859, to £523,100,229 in 1868. In the former period the amount of our foreign trade represented £11 17s. per head of the population; in 1868 £17 4s. 4d. per head. This is quite independent of the domestic trade, the statistics of which are inaccessible, but which probably largely exceeds the amounts engaged in foreign commerce. It has been ascertained that in London alone the payments and receipts exceed a thousand million pounds sterling per annum, the clearings of the city bankers alone amounting to £350,000,000, those of the Bank of England nearly an equal amount. The capital of the post-office savings' banks has been raised from £3,376,828 in 1863, to £11,666,655 in 1868. In our navigation, sailing vessels have increased from 18,675, representing 3,879,592 tons, and men employed 146,208, in 1859, to 20,526, representing 4,691,820 tons, and men 153,840, in 1868; of 895

steamers, 389,517 tons, 26,298 men, in 1859, to 1725 steamers, 824,614 tons, 43,662 men, in 1868; showing a total increase of vessels 2,680, tonnage 1,347,325, men 24,994. The railways show an increase of capital invested from £325,375,507 (1859) to £502,262,877 (1868); of traffic in 1859, 139,193,699 passengers; of traffic in 1868, 287,807,904 passengers; while the net receipts have risen from £12,288,524 to £19,631,047. The increase of the population in England and Wales has been 1,962,676; Scotland, 146,313; while in Ireland there has been a diminution amounting to 318,426, the average being 31,842 per annum. The amount of emigration from the United Kingdom was 1,701,504. The maximum emigration was in 1865, 209,801; the minimum in 1861, 91,770.

Among prominent *desiderata* in every department of local administration, an appropriate system of accountancy is to be advocated. Merchants and bankers almost universally adopt the same system of book-keeping, which the result of long experience has shown to be the best; but scarcely two counties in Great Britain use the same form in presenting their reports of receipts and disbursements; and in the very important departments, for example, in the prison returns, from the very different modes adopted in different localities, it is often utterly impossible to compare the details which make up the cost of the convict, or those which represent the various heads of the incomings to the credit of the gaol. In some instances no entries are made of the value of labour done within the prison; in some the labour accounts are confusedly blended with the general returns of the county treasurer; in some the manufacturing accounts are kept, as they ought to be, quite independently of those of the governor. If Parliament required—and it ought to do as is done in Scotland—that all prison accounts should be kept on the same models, and that those models should represent all the facts needful for the guidance of the Legislature—for providing economical management, and for perfecting discipline—there would be an immense saving of the public money, a diminution of recommitments, of criminals, and of crime.

It has been remarked and with much truth, that the value of the science of political economy would be very much augmented, if enquiry were pursued into the laws which regulate the distribution as well as those which regulate the production of wealth. The accumulation of wealth is no doubt in a variety of cases accidental, though as a general rule it is the result of aptitudes—intellectual, moral, or physical—applied to particular portions of the wealth-producing

field; and the results may be traced back to the original cause. But the spending or the distribution of wealth, however acquired, is subject to all the caprices and varieties of individual character, of social position, of accidental circumstances, and, of course, altogether beyond the control of human prudence, or to be provided against by mortal foresight. Into these regions of uncertainty statistics cannot penetrate.

But in the distribution of money there are many facts obtainable by the statesman which, if properly grouped, would furnish matter of the greatest value for the philanthropist to deal with. For example, how are wages spent by the working-classes in their different grades and occupations? Thus, if an agricultural labourer gains 12s. per week, what, as a general average, does he spend in rent, what in food, in clothing, in education, in amusements, in medicines? To ask what became of his savings would be almost an idle enquiry. Take a mechanic whose wages are 24s. a week, and how does he spend it, and what does he save, and how does he invest his economies?

The returns published by the municipality of Paris are exceedingly interesting, as showing the disbursements of the *ouvriers*, and even the *prolétaires*. I am not aware that there have been any analagous enquiries as to the manner in which the earnings of our agricultural labourers are disposed of. The statistics would be exceedingly interesting, but I am afraid very melancholy. They would indeed be valuable if they helped to encourage further enquiries into their condition. The savings of the working-classes, the provision for the future, as in the shape of life or fire assurance, are also lessons not to be forgotten.

A question on which statistics have not been practically, or at all events have been only partially, consulted, or if consulted have not obtained adequate attention, is that of direct compared with indirect taxation. Indirect imposts have undoubtedly the recommendation that they are voluntary contributions to the revenue. Men may abstain, if they please, from the consumption of taxed articles, or regulate the extent of consumption; and there may be the advantage of being ignorant of the extent to which the exciseman or the custom-house officer preys upon the income of the consumer. And it may be true—at all events it is seemingly true—that *non apparentibus et non existentibus eadem est ratio*. But it is a staggering fact, that nearly twenty-three millions sterling are collected by the customs on ninety-one

imported articles, of which twelve millions are received from four articles alone—tobacco, spirits, wine, and malt. There would be a great simplification of accounts, and a great diminution of the cost of collection, if duties were levied only on a few of the most productive articles. Such was the recommendation of the Parliamentary committee, of which Joseph Hume was the chairman; and the exchequer has suffered little, if at all, from the abolition of duty upon about one hundred articles. Among the beneficial changes which have taken place, the removal or modification of fiscal regulations, such as domiciliary visits, restrictions upon the various modes of manufacture, the interference of guilds and trade associations with apprenticeships, hours and forms of labour,—in a word, the gradual emancipation of capital and employment from ancient bondage. All have contributed to the great results which we witness on every side; and as the tendency to enquiry and the results of enquiry must be to substantiate by figures what has been accomplished, the evidences collected will serve as a guide for future legislation, as well as social or individual arrangements.

It is far more important to the community at large; for it is more intimately associated with the greatest happiness of the greatest number to know more of the manner in which wealth is spent, than to know how it is amassed; for they cannot be many who gather together enormous masses—the Rothschilds, the Barings—whether by their own talents and aptitudes, or whether, as in the case of many of the greatest landholders, from hereditary descent; but almost everybody has an interest in the expenditure of others, the unopulent especially, whose very existence depends upon the portion of money which is distributed to them in the shape of wages, and for other sources of a dependent character. What is to become of those gigantic fortunes which leave an enormous surplus after every desire has been gratified is a common subject of speculation. There are those who have to dispose of many millions a year. How can they be spent? And if not spent, the constant and ever-progressive accumulating goes forward. Is there any law, can there be any law, to check or influence this perpetual growth of, or will the chapter of accidents as it is called determine the future condition of the heirs to, uncounted and uncountable millions? Happily uncountable millions of money are not necessarily associated with maximized felicity.

Railway statistics can hardly be passed over in any review of the commercial position of nations, still less in their in-

fluence upon civilization and their contributions to human enjoyment. If any one had ventured to prophesy two generations ago that more than five hundred millions sterling would be invested in a new mode of travelling, by which, with far less risk than by the ancient conveyances, people were to be transported at the rate of from 20 to 40 miles an hour—that iron roads would be constructed, by which every considerable place in the United Kingdom would be connected with every other, and all the marvellous results, financial and moral, sketched out,—the visions would have been deemed as baseless as the promises of the alchemists in the dark ages to make gold out of stones; but the wealth which has been produced out of the stones, and timber, and iron, applied by science to the purposes of locomotion in the present and for the future, certainly exceeds in value all the gold and silver that circulate through the world. The “wealth of Ormus and of Ind” may be estimated. Not so the value which science has poured out from her ever-flowing streams. Contrast the caravan conveying a few hundred weight of the merchandize of the East on the backs of camels, requiring days of preparation for the journey, and the journey itself prosecuted through difficulties and dangers at the rate of $2\frac{1}{2}$ miles during eight hours per day, with the goods’ train behind a locomotive engine conveying hundreds of tons at a dozen miles an hour, collected and dispersed with all the facilities which machinery can apply! It is within my recollection that there were many roads leading to important places in this very county which no wheel carriage could pass, and where everything was conveyed on the backs of pack-horses, stumbling over the broken stones, and sometimes buried in the deep mud.

The electric telegraphs must not be forgotten. They have been, and will be yet more, the Internationalizers (if this word may be used); they have done more than the witchery of Shakespeare’s Puck was fancied to do—girdled the earth in forty minutes. It was my fortune to be present at the first exhibition of this new power to the Mandarins in China. Their curiosity was extreme, but it was mingled with wonderment and alarm. The messages were sent from one extremity of the line to the other. “We understand it,” they said; “you have a tube through which you have sent the message in a cannon ball.” But the promptitude with which an answer was returned, and the details given of what was doing at the farther end, which they had previously settled among themselves, and of which we could have no

knowledge, utterly perplexed them, and they exclaimed as the sole solution—"You and the devil understand one another."

Bankruptcy returns occupy an important place in the field of commerce and enquiry. The number of bankrupts, the amounts of their debts, the causes of the insufficiency of the laws which fail to protect the creditor against the fraudulent debtor, the aptitude of the machinery created for giving effect to these laws,—for these and similar enquiries statistics afford the only safe foundation for legislation.

A mass of novel information has lately been given to us from the agricultural statistics printed by the Board of Trade. As in countries where the capitation tax exists it is difficult to get returns, so in our own land there was great resistance among the farmers to the furnishing true information to the Government lest that information should lead to the imposition of new imposts. It is, however, discovered, in process of time, that knowledge is a great promoter of the well-being of the public, as well as of the individuals who value and apply it. The philosopher will busy himself with enquiries as to whether the same laws regulate the course of animal and vegetable life; how far and in what manner each can be made subservient to the improvement of the other; how far the soil, how far the seasons, are available for the melioration of the various types of existence. The tables will afford information to the landlord and the farmer as to comparative receipts of arable and pastoral cultivation, as to the state and numbers of live stock, and the proportion between supply and demand. These tables will throw light upon the various modes of agricultural management, the means of increasing produce by manure or other appliances; they will exhibit the contrasts between the districts where advantage has been taken and where not taken of mechanical and scientific discoveries. For example, in the county of Devon I had occasion to see, from the books of a distinguished manufacturer of agricultural implements, what a small proportion had been introduced compared to those employed in better cultivated tracts in England and Scotland. Then again the contrasts between large and small farms, between the poor, simple system of spade husbandry and the husbandry which turns the widest and the most advanced experience to the best account. In a large portion of this wide and interesting field the statistics are unmistakable, and will throw not a doubtful but a wondrous light upon enquiry.

May not the study of statistics have a moralizing effect upon public opinion? May it not influence sovereigns and

legislators, when the root of great national evils, and sometimes of great national events, is taken into account? As, for example, the returns of the waste of human life, of the sacrifices of money, which we owe to the devastations of war, though these sacrifices cannot be fully represented by statistical tables, but ramify into all the varieties of human suffering, and it is hoped that the startling facts in figures which have been published connected with international hostilities may not be deemed inappropriate, as they certainly cannot fail to be instructive.

In the Crimean war it is estimated that of the different armies engaged 784,991 were either killed in battle or died of wounds or diseases, of which the British contingent was 22,182. M. Paul Leroy estimates that the cost of this war was, to Great Britain, £74,230,468, reckoning the naval and military expenses; to France the cost was 1660 millions of francs (more than 66 millions of money); to Turkey 16 millions; to Piedmont two millions; while the pecuniary sacrifices of Russia were estimated by Leon Faucher at 3,183,000,000 francs, or above 127 millions sterling. The total expenditure for the war among the belligerents being above two hundred and eighty-five millions sterling. But as the neutral powers at the same time increased all their armaments, it is believed these extra expenses augmented the sacrifices to three hundred and twenty millions. What pecuniary loss is ever caused by the interruption of trade and other miseries are beyond the powers of estimate; and still less calculable are the personal sufferings caused by the havoc of war. The late internecine war in America is supposed to have cost the Federal States 950 millions sterling; the loss to the Confederates exceeds our means of estimate; while the sacrifice of life exceeded 800,000 human beings. Who can calculate the value of their labour lost to society! Dr. Larroque has made an estimate, whose accuracy has not been impugned, that the military establishments in Europe cost yearly above 280 millions sterling.

Sir Walter Trevelyan has expressed an opinion that government in our army system encourages intemperance and vice. He states that the expense of enforcing the Contagious Disease Act has increased in one year from £28,000 to £40,000, and the hospital votes from £275,589 to £380,771. The recruiting in public houses, the bad character of the enlisted, the habits of drunkenness, the allowance of beer money to the soldiers, and the "Prince Regent's allowance" of his pint of wine to the officers, are all contributing to the

habits of inebriety, while debauchery itself has received a sort of public sanction under the plea that it is preventive of greater evils.

A time may arrive in which the field of vital statistics may be greatly extended. For example; what are the effects of particular sorts of food upon longevity? In this county there are classes, especially in the poorer agricultural districts, in which animal food is scarcely ever tasted. In the East, among some hundreds of millions of the human race, there is no consumption of animal food, and an absolute abstinence from intoxicating drinks. The consumption of wheat is confined to a narrow circle; that of maize is probably greater; and assuredly that of rice very far greater indeed. I recollect being asked by a Chinaman what quantity of rice grew in my country? and when I told him "none," "O wretched land," he replied, "you must be under the curse of heaven." How far the species of food affects the corporeal powers of human beings it would be interesting to know. I have seen athletes among rice feeders in India, China, and Japan whose feats of strength could scarcely be equalled by European rivals; but these exceptional examples have been taller and stouter than the average size of the population. I have seen an African seize a fierce wild bull by the horns and fling him on the ground, keeping him there in a state of absolute subjection.

Second to none, and superior to most in importance, are the statistics of education. The cost of our schools would present interesting questions as to the results produced by the expenditure in the various establishments. Some statements made to the British Association by Professor Rogers were startling in thus exhibiting the great expenses and the poor results of college education.

The information possessed as to the pecuniary resources of many of our public schools is very fragmentary and unsatisfactory, but quite enough to show the desirableness of more revision and control. It would be possible to institute investigations as to the expenditure incurred and the benefits conferred, and after ascertaining what has been done, the still more important question as to what ought to be done—both for adults and for the young. What are the numbers of those who are utterly abandoned? At what cost can they be provided for? The statistics of education enforced by law may be studied in the Prussian returns, but most advantageously perhaps in the canton of Appenzell, where an uneducated person is scarcely to be found, and where the

sums applied to public instruction exceed the amounts expended on all other departments of the state. Some of the United States of America, particularly Massachusetts, could afford most instructive statistical details.

The Post Office statistics are among the most interesting. We have a pretty accurate knowledge of the number of letters received and despatched in the United Kingdom. The interest would be increased were it possible to ascertain the amount of correspondence through the civilized world. In China there is no national post office. When I was minister there, it required six months to receive an answer to a letter sent from Canton to Peking. Thirty years ago, when my official duties took me to Upper Egypt, a messenger followed me for three weeks in order to deliver a despatch from the Government. It would now require less than three days. And were it possible to estimate the circulation of newspapers in this and other countries, this would certainly be, if not a test of civilization, an evidence of the amount of interest felt in public affairs.

The number of books collected in the great libraries represent the gathered wisdom of the past—and the number of volumes is pretty accurately ascertained. But the quantity of books published in different countries is very imperfectly known; and of those deemed worthy of translation the list is very small. Of the best known and studied languages of the world the literature is almost required in the great interchanges of mind; but as the valuable books in the most accessible idioms are explored and exhausted, attention will no doubt be turned to regions less visited. The statistics of books published in different regions will no doubt furnish pabulum for future authors.

A Parliamentary enquiry is needed for examining into the institutions for the deaf and dumb. The disproportion of the cases in different parts of England remains to be accounted for. The number of cases which can be traced to hereditary infirmity, to consanguinity, or to other explicable causes will merit attention. The revenues of the various establishments—whence derived and how expended. My friend Dr. Scott has already called attention to this topic.

Another class of unfortunate beings—the blind—have been always objects of special sympathy. How far official attention might be properly directed to these classes as it is done to lunatics, paupers, and others, who are placed under the protection or surveillance of the public authorities, is a matter deserving examination.

The statistics of lunacy, or imbecility of intellect, in connection with our criminal population is well worthy of enquiry. Many of our very eminent judicial functionaries, while recognising among the dangerous classes much craft and cunning, have also observed that the general character of criminals, whether from indifferent or no education, or from causes not always traceable, are intellectually much under the average standard. In the convict prison of Millbank the average of insane or weak-minded persons exceeds 20 per cent.; in Perth prison it is officially reported that one out of every 140 is irresponsibly so. The judicial statistics for 1867-8 show that 1,244 criminal lunatics became, or were found, insane after sentence: a remarkable confirmation of the averment that solitary confinement very often leads to a disordered brain. Of 664 tried for murder, 108 were legally pronounced insane. The theories which connect insanity with crime, whether they involve irresponsibility or mitigation of penalty, are, though often contradictory, but to be solved by the facts which statistical investigation may gather together.

Notwithstanding the innumerable establishments for the alleviation or removal of the sufferings of the working-classes, the diminished price of wheat, the rise of wages, and many circumstances combining to render their position more comfortable, the statistics of pauperism are in the highest degree interesting and instructive, awakening as they must, a real concern for the widely-spread and still more widely-spreading evils, and a natural anxiety for the removal or mitigation of these too-visibly demonstrative evils, and their extending mischiefs. Taking averages of the years from 1853 to 1867, the poor-rate expenditure was, from

1853 to 1857	...	...	£5,600,000
1858 to 1862	...	...	£5,750,000
1862 to 1867	...	...	£6,500,000

The largest expenditures being for the two last years, averaging £6,700,000.

The number of paupers present an increase naturally proportionate to the increase of their cost. In 1860 there were relieved in 642 unions 844,875; in 1868 there were 1,040,103. If the population of England and Wales be 20,000,000, the pauperism exceeds 5 per cent., or 1 in 20 of the whole. London presents the most melancholy contrast between its ever-growing wealth and its ever-extending pauperism, where more than 130,000 persons receive parish relief. It is clear

that whatever our Poor Law legislation has done to relieve, it has wholly failed in its efforts to check the progress of pauperism, notwithstanding the munificent contributions to various charitable and benevolent, not always really beneficent, institutions, with which our country, and especially its metropolis, abound. Statistics can hardly follow the links by which poverty and crime are associated. The number of criminals who are not in jails is believed far to exceed the number who are imprisoned. The cost of crime has been estimated at from seven to eight millions yearly. We can calculate the loss from a bad system, but the profits, moral and pecuniary, of a better system, arithmetic cannot reach. The miserable mistakes of our prison discipline come prominently forward, and demand that attention from the Legislature which our county justices have failed to give. It is to be hoped that the action of Lord Lichfield will compel the magistracy to adopt arrangements which, either from ignorance or indifference, they have been too willing to repudiate or ignore. Education, recreation, are among the instruments suggested for ameliorating the condition of the working classes. They have their value, especially in so far as they co-operate to raise the moral tone of society. It has been averred, that of two hundred millions paid annually to the working-classes, sixty millions are spent in drink. Here the enthusiasm of zealous men may somewhat have exaggerated the mischief, but the mischief is monstrous, estimate it however we may.

The progress of Savings' Banks, now so much aided by their association with the Post Office, and the facilities given to depositors, is one of the marked improvements of the age, and an evidence that great numbers of the labouring classes begin to understand the value of economy, and the desirableness of making some provision for what they call "the rainy day." It is to be hoped that, as they better understand their true interests, instead of becoming members of benefit clubs, in which they are so often robbed and deluded, they will be more and more disposed to avail themselves of the simple official machinery now made accessible. Benefit societies held at public-houses frequently bring with them the evils of intoxication, waste of money, and destruction of family happiness. These evils are beyond the reach of statistical research, as are, on the other hand, the comforts which grow out of a prudential economising and far-sighted calculations.

If it be difficult to collect the statistics of misery and crime, still less accessible are those which represent the

amount of social and individual happiness and virtue. In the midst of much ostentatious beneficence, no doubt, there are some who

"Build a church to God, and not to fame."

Charitable institutions blazon out the names and the benefactions of their supporters, and deeds of public munificence are frequently proclaimed by loud trumpets from exalted places. But what are these compared in their influence upon the general felicity with

*"The little nameless unremembered acts
Of kindness and of love"*

that brighten the domestic hearth? Who can form any estimate, even approximative, of the pleasures created, of the pains alleviated or removed, by those constant daily solitudes and attentions exhibited in the paternal and filial, the brotherly and sisterly, and other family affections? While

*"The primal duties shine aloft like stars,
The charities which warm and bless
Lie scattered at the feet of man like flowers."*

Here, again, the thought is lost in the immeasurable; for the question might embrace all tribes and tongues, all religions, all usages. As everywhere, the fields of exploration are limitless here, and curiosity may find food for every speculation.

Statistics fail in a very large portion of the social field. Take the case of intemperance. Who can trace the mischiefs it produces when the drunkard is brought before the magistrate to be punished for his inebriety, or for crimes committed under its influence—in all these grades, from common assault up to manslaughter or murder? But what statistics can reach all the consequences in domestic misery, cruelty to wife, neglect of children, loss of wages, loss of health, loss of reputation? How can statistics pursue the results of crime in their multitudinous ramifications? The criminals who are handed by the police to the sessions or assizes may be grouped together—their numbers, their cost, their offences, their sentences, their re-committals, and other tangible and recordable facts, may be collected for the instruction of the magistrate and the lawgiver; but how imperfect are the statistics which would record the unsuspected, the undetected, the unconvicted, miseries which escape the control of public opinion or the action of the law? You may have the statistics of cottages and of schools, and show, however imperfectly, what has been done in the

education of the people; but by what machinery can you exhibit the whole extent of ignorance, and the amount of much of it, clouded by the presence and influence of that dimness and darkness which has been, not improperly, called "the father of evil," "the demon of society"?

If we seek the Statistics of Drunkenness, we may find some of the materials nearly complete—such as the quantity of alcoholic drinks produced and consumed; for that which does not pay duty is so comparatively small that it forms an element scarcely worth consideration, and we may follow to some extent the distribution of the liquids among the community. But when we enquire what portion is usefully and healthfully used, what innocently or without salutary or sanitary effects, and what perniciously or destructively, of these no satisfactory figures can be obtained. The records of sessions and assizes invite us to state how many are accused and convicted of drunkenness; but we are as much in the dark as to the multitudes that escape the cognizance of the constable, though assuredly it may be assumed that they greatly exceed those who figure in the police returns. It might be possible to form an approximate estimate of the number of those who frequent public-houses, and the proportion among them who indulge in drinking to excess; but who can penetrate into private houses, and state how much there is of social and how much of solitary inebriety? Who can pourtray the mischiefs and miseries caused by the abstraction of money for the purposes of drink? Who could specify the diminution of comforts and luxuries, to say nothing of the necessities, of life? What amount of pleasures might not have been enjoyed, what instructive books might not have been read, what becoming garments, instead of disgraceful rags, might not have been worn, what wholesome food and beverage instead of pestilent poison, what happy, well-ordered homes, instead of offensive hovels, of broken furniture, foul beds, and all the attendants of wretchedness and woe!

The statistics of emigration would be a valuable contributive to the history of nations. Who would have fancied such a development as the settlement of a few individuals from England has led to in the establishment of the United States, the Australian colonies, and other distant regions? The growth of nations, the mingling of races, the decay, the disappearance, or absorption of the inferior types of man, to give place to a constantly improving model. Associated with these changes is the accession of words to language, necessitated by growing wants and extending civilization.

It may be a question whether there is any topic of social or individual interest which is not in some way or other to be tested by statistical results; at all events it may be contended that when statistical results are attainable, they will tend much to the solution of any and every controversy. Every argument is strengthened if it can take a mathematical or arithmetical form; and the tendency of all enquiry is to subject every contingency to some law of harmony or order. The great controversy of the day is, whether any event in the widest regions of space or time escapes, or can escape, from the irresistible despotism of universal law. Thoughtful men are beginning to test the great workings of Providence, once deemed unapproachable, as they would test the working of any instrument produced by the hands of man. If they look at the machinery of a watch, they would judge of its excellence from the absence of aberrations—that it went well, and recorded the progress of days, or hours, or minutes, or seconds with unswerving accuracy. If it failed, they would properly deduce from its failure the imperfect hand of the watchmaker. It is not necessary that they should be personally acquainted with the watchmaker to assist the conclusion at which they would arrive. Nay; it would be actually impossible for them to trace the various parts of the complicated work to their origin. And so in the infinite variety of the machinery of creation. There the watch never fails; there there is no eruption, no convulsion, which is not a part of the great scheme of law. We no more see the Creator of the universe than we see the fabricator of the watch; but the evidence of the existence of the Framer is infinitely stronger than the evidence of the existence of the watchmaker, because the products of creation are infinite in number, and extent, and duration—the products of man, few, limited, and perishable. But in truth even in the world of imagination and figures play a prominent part: the poet *measures* his verses; we *sum up* the aptitudes or the defects of the painter; we *deduct* the shortcomings from the excellencies of the architect; and in cases of great architects, like Michael Angelo or Shakspeare, we cannot help *multiplying* their claims.

I may be accused of wandering too far into the domains of science, and of discussing questions which more especially belong to other departments than that to which these observations are devoted; but is it not true that all the departments of science are affiliated and connected to one another, and that in all that concerns this material world statistics are

a very valuable auxiliary? Wherever facts are associated with figures—and how very small a portion of the field is there in which figures are not or may not prove an important element!—and the nearer figures can be brought to represent or approximate to facts, the more accurate will be the conception of what is or ought to be. Mathematics and algebra, nay, poetry, music, painting, sculpture, and architecture themselves, represent proportions which bear a direct relation to numbers, and by the use of arithmetical signs will be better conceived. The fanciful song of the bard has its numbers, like the grave enumeration of the people in the Pentateuch, or in the returns of the Registrar General. Advocates are disposed, no doubt, to over-estimate the value of their own art or science; but the important position which statistics in their multifarious forms and varieties now occupy will serve, it is hoped, as a justification, at all events an apology, for the character of this address.

ON THE
FEASIBILITY AND ADVISABILITY OF HOLDING
INDUSTRIAL AND ART EXHIBITIONS AT THE
ANNUAL MEETINGS OF THIS ASSOCIATION.

BY J. PHILLIPS.

IN bringing this subject before the association, I would wish to present it in two distinct aspects.

1st. As a means of spreading and encouraging the attainment of scientific information ; and,

2nd. For the encouragement of the industries of the county.

I have made this division for the sake of convenience, and because there is a certain amount of distinctness in the two objects set forth ; and placed them in the order in which they stand because I regard the first as of the greatest importance.

I imagine all present would desire to see the spread of correct information with regard to those subjects, the advancement in our knowledge of which is one of the chief objects of the association. The Government, through the science and art department, greatly assists this ; but I think it can be shown that there is much yet left to be done.

I presume it is not necessary for me to say anything now as to the wisdom and feasibility of imparting scientific knowledge to the working classes ; for while I well remember, a few years since, a distinguished scientific gentleman saying that he had known a great attempt made in this direction, and all that resulted was an "immense failure," I am also aware that during the past winter many members of this association have been successfully engaged in imparting such information to those who are specially distinguished as "the people." I will therefore content myself with saying, that I believe here is to be found a wide field of kindly soil, wherein may be sown the seeds of scientific knowledge, with every promise of a rich and abundant harvest.

I have said, that the department of science and art do much for the spread of knowledge ; I have also said, that I think much remains to be done.

At the commencement of last winter, I received from South Kensington information respecting the establishment of science classes, and also the examination papers which had been used at the last examination, and I found that what was required of the students to enable them to answer even the easiest of the papers was very far in advance of anything that ordinary working men would be at all likely to attain in one season, and the effect was therefore at the very commencement most discouraging to would-be science students, of the very class that it would appear to be of the very highest importance to encourage by every possible means; for it is stated to be the *bona fide* working classes whom the Government are specially desirous to aid, but who it also appears in many cases are not the persons who actually receive that aid; and I am informed that the standard may not be *lowered* in consequence of the very large number of persons who now manage to avail themselves of the advantages offered. As far therefore as I am able to see, little is done towards the cultivation of science amongst the bulk of the working classes, those who are now students being quite the *élite* of that class, and persons of a somewhat higher grade.

Perhaps I may best set forth how I conceive these difficulties may be met, by briefly stating what on a very small scale has been tried at Bovey Tracey with, as far as the attempt went, an encouraging amount of success.

During the last summer an industrial exhibition was held there, which from every point of view was eminently successful, and great interest was manifested in the undertaking by the artisans of the place, the exhibition in the evenings being crowded to overflowing. A hope was expressed that the interest then manifested might lead to the formation in the village of classes for science and art during the ensuing winter, and that funds might be supplied by that exhibition to promote such classes; and as it was also then hoped that a similar exhibition would be held this year at Newton, the results of such work might then be brought forward, and prizes awarded.

At the commencement of the winter classes were opened; one for chemistry and one for drawing, in addition to others for the ordinary work of night schools. At Christmas a meeting was held, and the following report from one of the local papers will give some idea of the commencement which had been made:—

“The students of the night classes in connection with the Working Men’s Club were entertained on Monday evening,

28th Dec., in the large room opposite the Town-hall. After a tea a *conversazione* was held, which proved a great success in every way. Hung around the room were paintings and drawings (kindly lent for the occasion), including a number brought by Mr. Holmes, master of the Torquay and Newton Schools of Art, chiefly the work of his pupils. Many of the drawings were exceedingly well executed. On a screen were placed the works of the Bovey class, which, considering the short time it has been at work, reflected great credit on the pupils. The tables were supplied with portfolios of drawings, engravings, &c., also stereoscopes and a 'wheel of life.' The Vicar (the Rev. and Hon. C. L. Courtenay) addressed the students in encouraging terms, commending them for the work which they had performed, and pointing out the advantages which such a course of study as that now open to them would afford if diligently used. Mr. Phillips said there were now 25 students in the different classes, including a drawing and a science class. Very fair and, he thought, encouraging progress had been made. He urged the pupils to exercise all the pluck they possessed in overcoming the difficulties which they must expect to meet, and by hearty co-operation and perseverance to prosecute the work they had so well begun. They were sometimes told that a little learning was a dangerous thing, which he believed was quite correct, but they were aiming at that amount of learning which carried them past that point, to the stage where they should learn, what they perhaps did not now all of them think, that they really knew very little indeed, when they saw what there was yet to learn. He thanked most heartily the ladies and gentlemen who had afforded such an interesting evening to the students and their friends. The evening was enlivened at intervals with music and reading by some of the company who were present. In addition to the classes connected with the club, there are more than fifty lads in the night school, which is under the able management of Mr. Westwood, the parish schoolmaster."

This was quite the first acquaintance of these people with science or art under any form, and it will not be difficult to imagine that some little time would have to be spent in their becoming accustomed to the nature of such study, and to the phraseology which is absolutely necessary even after the subject is divested as far as possible of technicalities; but at the same time I also think it will be seen that these persons, having the wish for such information, are of all others those to whom it would be most desirable to impart it by every available means.

One of the most available means for accomplishing this would be by a society, such as the Devonshire Association, affording aid somewhat after the manner of the Department of Science and Art; in fact, supplementing the work of the department; and thus encouraging the acquirement of knowledge at a much earlier stage than is now recognized by South Kensington; and that prizes might be offered for competition, and certificates awarded on attaining certain standards; and opportunities afforded for exhibiting results where they were of a nature suitable for exhibition; and this kind of encouragement might be extended to scholars in parochial and British schools, &c. Though at first the scheme might not be fully comprehended, nor the efforts put forth meet with as free a response as could be desired, yet by persevering for a few years, from what I have seen in connexion with workmen's improvement societies (with which I have now been intimately connected for more than ten years), I feel fully convinced that success would ultimately attend the effort, and that it would become the rule that in towns where such exhibitions were held classes such as I have described would be established, and the recognition which annual exhibitions would afford would prove a great incitement to work in this direction.

The establishment of annual exhibitions would also tend greatly to encourage, as in fact the exhibition in two successive years in Bovey did encourage, works requiring much study and skill, and correct information in their production, such as models of buildings, engines, &c., constructed to scale, and made entirely by apprentice lads, and I am in a position to say that but for those exhibitions these models in particular would not have been produced, nor the study undertaken, nor the necessary correct information acquired by the lads who produced them, and who are now undertaking more difficult work, requiring increased knowledge.

With sufficient recognition I maintain that the number of those who would be willing thus to employ their leisure hours would be very largely increased; and further, that the persons so employed would be led to love that knowledge which they found could be turned to so much account in the production of works of art and utility.

It is now my object chiefly to set forth the encouragement which the means I have mentioned would afford to the acquirement of knowledge. It is not difficult, however, to understand that there are many other benefits which would result in connexion with such exhibitions.

At present when lads leave the parish school, and are

apprenticed, every incentive to intellectual pursuits is at once practically closed to them. They no longer study under fear of the rod, nor is there held out to them the encouragement of obtaining a prize. They find that to be on a footing with their associates they must accustom themselves to the use of tobacco and beer, and probably skittles, or just now cards. The sharpest and cleverest among them take to study of a kind the following out of which introduces them to the police-court, as modern and juvenile highwaymen and the like.

But let there be an institution which could make the consideration of these cases one of its specialities, and I can see no great difficulty in attracting the majority of these lads, and encouraging them to follow out some one intellectual pursuit up to the point of gaining a love for it, and then continuing it for its own good sake, and for the good which they experience in themselves from the course which they have been induced to adopt.

Hitherto no such institution seems to have taken this up, and successfully carried it out. Much fostering care and gentle and judicious treatment is needed; much of patience and perseverance; love of the work itself; the spread and increase of scientific knowledge; love for the object to be attained; the raising intellectually of the mass of the people; these properties exercised by a committee of management will assuredly not fail to attract to their work a very large number of the poor and now neglected classes.

Having set before them annually an opportunity of exhibiting the work of their leisure winter hours, of turning that work to profitable account, of at the least having it held up to observation, and securing to themselves a share in some grand holiday, they will not fail to recognize such opportunities. Each year it will be found that fresh exhibitors come forward, encouraged by the work of their neighbours; and so they would be *led*—not driven as at school—to enjoy and appreciate knowledge. First it may be for the annual holiday and possible distinction, and subsequently for the increased and continued pleasure they may derive by its means from surrounding objects which have hitherto been to them unrecognized, unknown, almost unseen.

As a means of promoting the industries of the county, I think such annual exhibitions might be useful in many ways. It must not be forgotten that Devonshire was once one of the leading manufacturing counties of England, and now that the coal districts take the lead, people are very apt to look to the middle of England for any manufactured goods which they

require; first because they are to a great extent ignorant that their wants may be supplied nearer home, and second because they cannot now-a-days conceive that anything fabricated out of the "manufacturing districts" can be good. A "lady from the country," a few years since, entered an earthenware shop in Exeter, and requested to be shown some ware of Staffordshire make. Being of a domestic turn, and accustomed to handle the crockery at home, she closely examined the articles which were brought to her, and said that she was too much accustomed to make purchases to be so readily deluded. The ware they had brought to her was not Staffordshire but Bovey. She suspected it as soon as she saw it, and now she was sure, and she was not going to have any of that rubbishy Bovey ware palmed off upon her. The manager of the Bovey Pottery, who happened to be standing by, felt greatly surprised at this denunciation of his work, as well as at the lady's powers of discernment. He was considerably reassured, however, when he saw the shopkeeper take up another dish of veritable Bovey manufacture, and ask if *that* was more like what the lady wanted. She immediately said it was. She could at once perceive the difference, and had no doubt that was true Staffordshire ware. "Well, mam," said the shopkeeper, "this is a superior article, and we are obliged to charge more for it; and I thought you were wanting something that was cheap." The good lady paid the higher price, and went home quite satisfied with her purchase.

Many persons are surprised when they hear of the woollen factories in the county, and of the numerous manufactories for paper, silk, lace, chemicals, artificial manures, soap and candle, sugar refining, &c., as well as pottery works, where both fine and coarse pottery is made, also fire bricks (rivaling even those of Stourbridge), and different kinds of terra cotta and architectural ware.

But it is not these manufactures which I think will be mostly benefited by such exhibitions as I advocate. It is rather those lesser industries which bring out most conspicuously the work of the individual. Such an exhibition should, I think, be divided into sections for the different trades, as carpenters, cabinet-makers, smiths, stonemasons, plasterers, shoemakers, &c. And not only would these trades thus have afforded them opportunities of comparing their productions, but by examples, which must be collected in a loan department, also of studying the productions of other countries, which would probably give greater instruction in improving and rendering more beautiful their work than they could

obtain by any other means. To quote the words of the president of the industrial exhibition at Bovey last year: "One great advantage of exhibitions such as these is, that they not only serve as a rapid means of obtaining information, but they also afford a rapid and easy way. It is always a very different matter to see things than to be told about them. We may read or hear descriptions of things continually, but may gain very little idea about them. . . . By seeing them as we do in an exhibition, our knowledge of them is more complete than any description can make them to us."

It thus appears to me to be very desirable indeed that such exhibitions should be promoted, both with a view to the diffusion of correct and precise information, which, I think, may be regarded as more especially the work of scientific associations, and also for the encouragement which would be given to the industries, both great and small, of the county, by bringing them prominently before the public, and by exhibiting to the workers in the different branches of industry the (possibly in some branches) more perfect and more beautiful productions of other districts.

I think the plan of connecting such exhibitions with the annual meetings of this association would be found quite feasible, entailing comparatively little additional work, and adding greatly to the popularity and, I think, the usefulness of this association. A committee, with certain permanent officers, might be appointed, with a staff of paid assistants, who would become familiar with the arrangements, and so greatly simplify the work. The expenses would, I think there can be little doubt, be very much more than met, and a fund raised for assisting poor exhibitors in sending to and visiting the exhibition.

And I think it will not be difficult to see, that as the working of the scheme became well understood, and exhibitors among the working classes saw that year after year opportunities were afforded them of displaying their handiwork, and of competing for recognition, their numbers would yearly increase, and their interest be maintained, and thus we should find that we had succeeded in encouraging to a pursuit of science a larger number of "the people" than perhaps might be done by any other means, and our association would become one not merely of those who are already interested in science and art, but, on a larger and wider basis, one for the "advancement of science, literature, and art."

General Statistics during the five years ending

		1866	1867	1868	Average.
1	Total fall in inches	40.69	42.11	39.19	38.54
2	„ gallons per acre	20,511	952,635	886,577	871,873
3	„ tons per acre	4,121	4,265	3,969	3,903
4	„ relative fall	1056	1093	1017	1000
5	Actual number of	218	190	171	185
6	Relative ditto	118	103	92	100
7	Average daily fall	.19	.22	.23	.21
8	Days of excessive f	72	64	60	62
9	„ defective c	142	125	108	121
10	„ average c	4	1	3	2
11	Greatest fall in 24	1.18	1.55	1.62	1.53
12	Relation to annual	29	37	41	40
13	Date of greatest fa	Jan. 10	May 12	Nov. 21	
14	Longest rainless in	11	14	25	23
15	Date of ditto	July 16 to July 26	Nov. 15 to Nov. 28	May 25 to June 18	
16	No. of rainless inter	5	7	8	7
17	Month of greatest	Sep.	March	Dec.	
18	Its fall in inches	8.89	6.99	8.90	7.44
19	Relation to annual	218	166	227	193
20	Three wettest cons	Jan. Feb. March	Jan. Feb. March	Oct. Nov. Dec.	
21	Their total fall in i	14.54	16.05	15.55	14.63
22	Relation to annual	357	381	397	380
23	Month of greatest	Sep.	Oct.	Dec.	
24	Its number of ditt	29	26	30	26
25	Relation to annual	134	137	175	140
26	Month of least fal	June	June	July	
27	Its fall in inches	.95	.88	.28	.52
28	Relation to annual	23	21	7	13
29	Three driest consec	June, July, August	Oct. Nov. Dec.	May, June, July	
30	Their total fall in i	4.60	6.87	2.33	4.70
31	Relation to annual	113	163	59	122
32	Month of least No.	July	Nov.	June	
33	Its least number	11	4	3	5
34	Relation to annual	50	21	18	27

THE RAINFALL ON THE ST. MARY CHURCH ROAD, TORQUAY, DURING THE FIVE YEARS ENDING DECEMBER 31, 1868.

BY W. PENGELLY, F.R.S., F.G.S.

HAVING carefully measured and registered the rain which fell on the St. Mary Church Road, Torquay, during the five years ending December 31st, 1868, I have from the materials thus collected constructed a series of tables which, with a few explanatory remarks, I now beg to lay before the Association.

It may, perhaps, be well to state that I use one of the five-inch gauges made by Mr. Cassela, under the auspices of the British Association for the Advancement of Science; that it is placed, with its top nine inches above the ground, in the middle of a small lawn, 200 feet above the sea; that the nearest arm of the sea is Torbay, about one mile to the south; and that the centre of Dartmoor—the great upland of Devonshire—bears W.N.W., and is nineteen miles distant.

TABLE I

In Table I. the first line shows the annual rainfall during the five years, and also the average fall per year during the same period; from which it appears that 1864 alone was below the annual average, and that of the remaining four years, 1865 was the wettest and 1868 the driest.

In the second line the rainfall is reduced to gallons, and in the third to tons, per acre. The latter is based on the assumption that a cubic foot of water weighs 1000 ounces Avoirdupois—an estimate rather below than above the truth.

The 4th line shows the *relative* falls; the annual average being put = 1000, and the actual annual falls equated to it. Thus, in 1864 the fall was .359 below the average of the five years, whilst that in 1865 was .190 above it.

The 5th line shows the number of “wet days;” that is, of days on which there fell not less than .01 inch—the least quantity which is measured. It appears that, on the average,

rather more than half the days of each year were wet ones ; that 1864 was, in this sense also, the driest year of the five ; and that 1866 was the wettest, though it was surpassed in its rainfall by both 1865 and 1867.

The 6th line shows the *relative* number of wet days, and is calculated by putting the average annual number = 100, and equating the actual number in each year to it. From this line it appears that the fluctuation, from year to year, in the number of wet days, was less than that of the rainfall ; the former ranging from 9 per cent. below to 18 per cent. above the average, whilst the latter oscillated from 36 per cent. below to 19 above,—a total range of 27 against 55, or as 1 to 2. It is also seen that whilst there was but one year of defective rainfall, there were two in which the number of wet days was below the average.

The “average daily fall,” shown in the seventh line, is determined by dividing the rainfall of each year by its number of wet days. It was greatest in 1865, and least in 1864. In other words, the amount of rain in relation to the number of wet days was unusually great in the former ; or, what amounts to the same thing, the number of wet days was, as compared with the average, small for the rainfall. Two years only had a mean daily rate below the average for the five years. As might have been anticipated, the days on which the fall was above the average rate were in every year less numerous than those on which it was below. From the eighth and ninth lines it appears that for the entire period these days were very nearly as 1 to 2.

The 10th line shows that the days on which the actual rate was the same as the average were very few, and, for the entire five years, amounted to no more than two per year.

From the 11th line it is seen that the dry 1864 and the wet 1865 were indicated, so to speak, by their greatest falls in 24 hours ; that of the former being no more than 1·15 inch, whilst that of the latter amounted to as much as 2·13 inches—the former being, as the twelfth line shows, ·047, and the latter ·046 of the yearly falls respectively. These were the least and the greatest maximum falls in 24 hours during the five years. On the average the maximum fall in 24 hours amounted to 1·53 inch, or about 4 per cent. of the average annual fall.

The 13th line shows that the heaviest fall in 24 hours was not confined to any particular season or part of the year.

The longest periods without rain in the different years had nothing like an approach to uniformity in their duration, as

is shown in the 14th line; amounting to 11 days only in 1866, but to as many as 44 in 1865. It also appears that the duration of the longest rainless period of a year afforded no criterion as to the character of the year as a whole: 1865 surpassed all the other years in the duration of its longest rainless period, and also in its total amount of rain. It, moreover, surpassed two of the years in the number of its wet days.

With the exception of 1868, the longest rainless periods of the several years occurred after Midsummer, but not in the same month in any two years, as is shown in the 15th line. It may be remarked also that 1868 formed an exception as to the date of its heaviest fall in 24 hours. It occurred after Midsummer, whereas in all the other years it was before, as is shown in the 13th line.

The 16th line shows that the number of rainless periods of at least a week's duration each, ranged from 5 to 8 per year, and averaged 7. They were most numerous in the two driest years—1864 and 1868,—but not least numerous in the years of heaviest annual falls. They were somewhat more closely related to the total number of dry days in their respective years.

The 17th line shows that the month of greatest fall in each year was, with the exception of 1866 only, always between Midsummer and Christmas, but never the same as the month in which occurred the greatest fall in 24 hours.

As is seen in the 18th line, the maximum monthly falls varied from 3·79 inches, in November, 1864, to 8·90 inches in December, 1868; or, as it is put in the 19th line, from ·153 to ·227 of the total rainfalls in their respective years.

The 20th line shows that the three wettest consecutive months have always been the first or the last three of the year; the former having obtained this distinction three times and the latter twice. Their united rainfalls have varied, as is seen in the 21st line, from 8·33 inches in 1864 to 18·69 inches in 1865, or, as is set forth in the 22nd line, from ·336 to ·407 of the total fall in their respective years. It may be remarked in passing that the fall in December 1868 alone, exceeded the united falls of the three wettest consecutive months in 1864. October, November, and December in 1865 were the three wettest consecutive months during the five years. The month of greatest fall was not in all cases one of the three wettest consecutive months.

It appears from the 23rd line, that the month of the greatest number of wet days oscillated from September to

March inclusive, omitting both November and January. September alone, during the five years, was twice distinguished for its excessive number of wet days, but on one of these occasions (1864) it was bracketted with March. The month thus prominent was not in all cases one of the three wettest consecutive months.

Lines 24 and 25 point out that the maximum number of wet days per month varied from 21 in 1864, to 30 in 1868, and averaged 26; or from 12·5 to 17·5 per cent. of the total number of wet days in their respective years. Neither September in 1866, nor December in 1868, had more than one rainless day.

In September, 1865, as the 26th line shows, no rain fell during the entire month. No other instance of a rainless month occurred during the five years, and the instance just mentioned happened in the wettest year of the five. During the remaining four years, June and July equally divided the honour of being the driest months.

The 27th and 28th lines show that the minimum monthly fall ranged from 0 in September 1865, to 0·95 inch in June 1866, and averaged 0·52 inch. The fall during the driest month appears to have had no relation to the rainfall of the year. The least monthly minimum occurred in 1865—the wettest of the five years,—and the greatest in 1866, the rainfall of which exceeded that of two, and was also exceeded by that of two years. The minimum monthly fall never exceeded ·023 of the total fall of the year. On the average it amounted to ·013 of it.

According to the 29th line, the three driest consecutive months ranged from March to December inclusive, with the omission of September. On comparing the 20th and 29th lines it will be seen that October, November, and December were in one year the three driest, and in two others, the three wettest consecutive months of the year.

We learn from the 30th and 31st lines that the total fall of the three driest consecutive months varied from 2·33 inches in 1868, to 7 inches in 1865, and averaged 4·7 inches; or from ·059 to ·153 of the annual falls in their respective years, the average being ·122.

The month of least number of wet days according to lines 32, 33, and 34 oscillated from June to November, with the omission of August and October. The number of days varied from 0 in September 1865, to 11 in July 1866, and averaged 5; or from 0 to 5 per cent., and averaged 2·7 per cent.

TABLE II.

Showing the actual and average Rainfall in inches, on St. Mary Church Road, for every month during the five years ending December 31, 1868.

	1864	1865	1866	1867	1868	Average
January	2.76	5.98	6.58	6.00	4.95	5.25
February	2.37	4.44	4.67	3.06	1.96	3.30
March	3.20	2.05	3.29	6.99	2.23	3.55
April	1.23	0.81	2.39	2.90	2.78	2.02
May	1.60	4.14	2.43	5.42	1.72	3.06
June	1.36	3.06	0.95	0.88	0.33	1.32
July	0.49	2.21	1.54	5.45	0.28	1.99
August	0.83	4.49	2.11	1.74	3.87	2.61
September	1.98	0.00	8.89	2.80	5.52	3.84
October	1.68	8.62	3.24	3.13	2.41	3.82
November	3.79	5.58	1.63	1.39	4.24	3.33
December	3.53	4.49	2.97	2.35	8.90	4.45
Totals	24.82	45.87	40.69	42.11	39.19	38.54

Table II. shows the actual and average fall in inches for each month during the five years. It ranged from 0 in September 1865, to 8.90 inches in December 1868. Were we to put the average January fall during the five years = 1000, and equate the other monthly averages to it, the twelve months would stand, in descending order, as in Table III.

TABLE III.

Showing, *relatively*, the average Rainfall of each month, on St. Mary Church Road, during the five years ending December 31, 1868.

1 January	=	1000	7 February	=	629
2 December	=	848	8 May	=	583
3 September	=	731	9 August	=	497
4 October	=	728	10 April	=	385
5 March	=	676	11 July	=	379
6 November	=	634	12 June	=	251

It is, perhaps, noteworthy that the fall in December 1868, was exactly double the average fall of the same month during the five years. June and October 1865, July 1867, and September 1866, exceeded their respective averages for the five years in a still higher ratio.

TABLE IV.

Showing, *relatively*, the Rainfall of each month as compared with the total Fall of the year to which it belonged.

	1864	1865	1866	1867	1868	Averages
January	111	130	162	142	126	136
February	95	96	115	73	50	86
March	129	45	81	166	57	92
April	50	11	59	69	71	52
May	64	90	60	129	44	79
June	55	67	23	16	8	34
July	20	48	38	129	7	52
August	33	98	52	41	99	68
September	80	0	218	66	141	100
October	68	188	80	74	61	99
November	153	121	40	33	108	86
December	142	98	73	55	227	115
Totals	1000	1000	1000	1000	1000	1000

Table IV. shows the *relative* monthly falls in each of the five years, and has been calculated by putting the total fall for each year = 1000, and equating the monthly falls to it. For example, in 1864, the yearly fall : January fall :: 24·82 : 2·76 = 1000 : 111, and so on.

An examination of this Table shows that, whilst each month was subject to considerable fluctuations, January was the most, and September the least uniform in the per centage which it contributed to the year's total. The former, on the average the wettest month in the year, ranged from 111 to 162, and September, from 0 to 218—the lowest and highest numbers in the Table.

The right hand column of the Table shows, *relatively*, the average fall of each month as compared with the average yearly fall.

Taking the difference of the extremes of fluctuation as an index of their character, the months stand, in descending order, as in Table V.

TABLE V.

Showing, *relatively*, the Range of Fluctuation of each month, during the five years, in its Annual Contribution to the total Rainfall of the year.

1 January	=	51	7 November	=	120
2 June	=	59	8 March	=	121
3 April	=	60	9 July	=	122
4 February	=	65	10 October	=	127
5 August	=	66	11 December	=	172
6 May	=	85	12 September	=	218

It is obvious from the foregoing figures, that the fall of a single month fails to furnish data for anything like an approximation to the total fall of the year to which it belongs. For example, during January of the present year (1869), there fell on the St. Mary Church Road 5·90 inches of rain. This enables us to say no more than that, according to the results of the last five years, the total fall of 1869 will neither exceed 53·15 inches ($= 5·90 \div \cdot 111$), nor fall below 36·42 inches ($= 5·90 \div \cdot 162$); and January, it will be remembered, furnishes, on the average, more abundant data, and is more uniform in the quota which it furnishes to the rainfall of the year, than any other month.

TABLE VI.

Showing, *relatively*, the Rainfall of each month during the five years, as compared with average of the same month for the entire period.

	1864	1865	1866	1867	1868	Averages
January	526	1139	1253	1143	943	1000
February	718	1345	1415	927	594	1000
March	901	577	927	1969	628	1000
April	609	401	1183	1436	1376	1000
May	523	1353	794	1771	562	1000
June	1030	2318	720	667	250	1000
July	246	1111	774	2739	141	1000
August	318	1720	808	667	1483	1000
September	516	0	2315	729	1438	1000
October	440	2257	848	819	631	1000
November	1138	1676	489	417	1273	1000
December	793	1009	667	528	2000	1000

Table VI. shows *relatively* the fall of every month for each of the five years, as compared with the average of the same month for the entire period, and is thus calculated:—Table II. shows that the average January fall, for example, during the five years, was 5·25 inches, whilst the actual fall in 1864 was 2·76 inches. Putting the former = 1000, we have $5·25 : 2·76 = 1000 : 526$, and so on for the other years and months.

An analysis of this Table brings out the fact that the actual rainfalls, from year to year, differed from the average of the five years much more in some months than in others. The characters, in this respect, of the various months are shown in Table VII., in which the number set down against each month is the difference between the greatest and least *relative* fall of the month during the five years, as set down in Table VI.

TABLE VII.

Showing, *relatively*, the Range of Fluctuation of each month during the five years, as compared with the average fall of the same month during the same period.

1 January	=	727	7 August	=	1402
2 February	=	821	8 December	=	1472
3 April	=	1035	9 October	=	1817
4 May	=	1248	10 June	=	2068
5 November	=	1259	11 September	=	2315
6 March	=	1392	12 July	=	2598

It may be mentioned that January and February were the only months in which the range from minimum to maximum fall was less than the average fall, and that in June, July, and September the range was more than double the average fall (1000).

On comparison it will be found that Tables V. and VII. have not even a near approach to identity in the order of the months.

TABLE VIII.

Showing the actual and average number of Wet Days in each month during the five years.

	1864	1865	1866	1867	1868	Averages
January	15	21	25	17	21	20
February	17	22	21	19	12	18
March	21	14	19	23	22	20
April	10	12	19	19	10	14
May	11	19	15	19	7	14
June	15	5	12	10	3	9
July	7	15	11	16	6	11
August	8	17	17	11	15	14
September	21	0	29	13	13	15
October	10	20	12	26	19	17
November	20	18	19	4	13	15
December	13	17	19	13	30	18

Table VIII. shows the actual number of wet days in each month during the five years, and also the average number for each month during the same period. The only rainless month was September 1865. No month had rain on every day; the nearest approaches to this state were September 1866, and December 1868; each having one dry day only. Though March averaged a less rainfall than January, the two months had the same average number of wet days, each having two wet days for every dry one.

TABLE IX.

Showing, *relatively*, the number of Wet Days in each month, as compared with the total number in the year to which it belonged.

	1864	1865	1866	1867	1868	Averages
January	89	117	115	89	123	108
February	101	122	96	100	70	97
March	125	78	87	121	129	108
April	60	67	87	100	58	76
May	65	106	69	100	41	76
June	89	28	55	53	18	49
July	42	83	50	84	35	59
August	48	94	78	58	88	76
September	125	0	133	68	76	81
October	60	111	55	137	111	92
November	119	100	87	21	76	91
December	77	94	87	68	175	97
Totals	1000	1000	1000	1000	1000	1000

Table IX. shows *relatively* the number of wet days in each month, as compared with the total number in the year to which it belonged, the latter being put = 1000, and the former equated to it. It will be found that the range of fluctuation, *i.e.* the difference between the maximum and the minimum numbers registered against the several months, is least in the case of January, greatest in that of September, and that if arranged, in descending order, according to this range, so as to show the greater or less uniformity with which they annually contribute to the wet days of the year, the months stand as in Table X.

TABLE X.

Showing, *relatively*, the Range of Fluctuation of each month, during the five years, in its Annual Contribution to the total number of wet days in the year to which it belonged.

1 January	=	34	7 May	=	65
2 April	=	42	8 June	=	71
3 August	=	46	9 October	=	82
4 July	=	49	10 November	=	98
5 March	=	51	11 December	=	107
6 February	=	52	12 September	=	133

It will be observed that the order of the months in this Table is, in most cases, very unlike that of Table V.; that is, the order in which the months on the average contributed to the rainfall of the year, differs widely from that in which they supplied wet days.

TABLE XI.

Showing, *relatively*, the number of Wet Days in each month during each of the five years, as compared with the average number in the same month for the entire period.

	1864	1865	1866	1867	1868	Averages
January	750	1050	1250	850	1050	1000
February	944	1222	1167	1056	667	1000
March	1050	700	950	1150	1100	1000
April	714	857	1357	1357	714	1000
May	786	1357	1071	1357	500	1000
June	1667	556	1333	1111	333	1000
July	636	1364	1000	1455	545	1000
August	571	1214	1214	786	1071	1000
September	1400	0	1933	867	867	1000
October	588	1176	706	1529	1118	1000
November	1333	1200	1267	267	867	1000
December	722	944	1056	722	1667	1000

Table XI. is intended to show how far the number of wet days in each month annually agreed with the average number for the same month during the five years. It is constructed on the principle so frequently used in this paper. The number of wet days in January, for example, was 20 on the average, and in 1864 the actual number was 15. Putting the former = 1000, we have $20 : 15 = 1000 : 750$, and so on for the other years and months. The maximum and minimum numbers thus obtained for January, for example, were 1250 and 750, hence the difference, or range of fluctuation, was 500. Arranging the months, in descending order, according to this range, so as to show their relative divergence from uniformity in their annual number of wet days, they stand as in Table XII.

TABLE XII.

Showing, *relatively*, the Range of Fluctuation of each month, during the five years, as compared with the average number of wet days of the same month during the same period.

1 March	=	450	7 July	=	910
2 January	=	500	8 October	=	941
3 February	=	555	9 December	=	945
4 April	=	643	10 November	=	1066
4 August	=	643	11 June	=	1334
6 May	=	857	12 September	=	1933

TABLE XIII.

Showing the average daily rate of Rain in inches, for every month during each of the five years, as well as during the five years as a whole.

	1864	1865	1866	1867	1868	Averages
January	'18	'28	'26	'35	'24	'27
February	'14	'20	'22	'16	'16	'18
March	'15	'15	'17	'30	'10	'18
April	'12	'07	'13	'15	'28	'14
May	'15	'22	'16	'29	'25	'22
June	'09	'61	'08	'09	'11	'15
July	'07	'15	'14	'34	'05	'18
August	'10	'26	'12	'16	'26	'19
September	'09	'00	'34	'22	'42	'25
October	'17	'43	'27	'12	'13	'22
November	'19	'31	'09	'35	'33	'22
December	'27	'26	'16	'18	'30	'24
Means	'15	'25	'19	'22	'23	'23

Table XIII. shows the average daily rate of rain, on the days on which rain fell, for every month during the five years, as well as the average for the five years as a whole; and was calculated, of course, by simply dividing the monthly rainfall by the monthly number of wet days. During the five years, the greatest daily rate was in June 1865, when it amounted to the large quantity of '61 inch per day. On the average of the five years, however, January headed the list, and April closed it; that is, January had the greatest amount of rain for the days on which it fell, or the smallest number of days for the rain which fell, or rained the most industriously whilst it was about it: and the reverse of all this obtained for April.

TABLE XIV.

Showing, *relatively*, the Fluctuation in the rate of daily Rainfall, in each month year by year, as compared with its average daily rate during the five years as a whole.

	1864	1865	1866	1867	1868	Averages
January	667	1037	963	1296	889	1000
February	778	1111	1222	889	889	1000
March	833	833	944	1667	556	1000
April	857	500	929	1071	2000	1000
May	682	1000	727	1318	1136	1000
June	600	4067	533	600	733	1000
July	389	833	778	1889	278	1000
August	526	1368	632	842	1368	1000
September	360	0	1360	880	1680	1000
October	773	1955	1227	545	591	1000
November	864	1410	410	1591	1500	1000
December	1125	1083	667	750	1250	1000

Table XIV. is intended to show the range of fluctuation in the rate of the daily rainfall, in each month, year by year, as compared with its average daily rate during the five years; the latter being put = 1000, and the former equated to it.

When arranged, in descending order, according to their range of fluctuation, *i.e.* the difference between the greatest and least relative rate in Table XIV. the months stand as in Table XV.

TABLE XV.

Showing, *relatively*, the Range of Fluctuation in the rate of daily Rainfall for each month during the five years.

1 February	=	444	7 November	=	1181
2 December	=	583	8 October	=	1410
3 January	=	629	9 April	=	1500
4 May	=	636	10 July	=	1611
5 August	=	842	11 September	=	1680
6 March	=	1111	12 June	=	3467

TABLE XVI.

Table XVI. shows the number of days in each year on which given falls were measured, and needs no explanation. During the five years the number of days on which the fall exceeded an inch were 17, upwards of 1.5 inch fell six times only, and only one instance occurred of a fall exceeding two inches.

		1864	1865	1866	1867	1868	Mean.
Days on which	·01 inch fell	28	15	26	23	22	23
	·02 "	18	15	17	17	12	16
	·03 "	9	5	18	10	10	10
	·04 "	7	10	7	11	7	8
	·05 "	13	9	13	5	6	9
	·06 "	8	10	7	4	3	6
	·07 "	5	6	9	2	3	5
	·08 "	10	5	4	3	1	5
	·09 "	6	4	2	4	3	4
	·10 "	4	1	6	6	7	5
from	·11 to ·20 "	15	30	38	38	29	30
	·21 to ·30 "	19	13	29	20	24	21
	·31 to ·40 "	10	14	13	18	10	13
	·41 to ·50 "	9	12	8	7	11	9
	·51 to 1·00 "	7	25	17	18	20	17
	1·01 to 1·50 "	0	4	4	1	2	2
	1·51 to 2·00 "	0	1	0	3	1	1
	Above 2·00 "	0	1	0	0	0	0

The mild character of the winter of 1868–9 was, of course, noted by every one. As is common when anything unusual occurs in our meteorological phenomena, the Gulf Stream was supposed to be out of order, and the blame was laid on it. It may be doubted, however, whether in order to explain the high temperature it is necessary to do more than to recognize the direct and indirect thermal effects of the protracted heavy rainfall already alluded to.

1st. Such a rainfall implies the prevalence of wet, that is south-westerly, that is hot winds.

2nd. It implies an atmosphere supersaturated with aqueous vapour, which, it is well known, greatly retards the loss of radiant heat by the earth.

3rd. The conversion of water from the vapourous to the liquid state, is necessarily attended with the passage of heat from the so-called *latent* to the *sensible* condition. In other words, being no longer employed in doing the work of keeping water in the form of vapour, the heat performs that of raising the temperature of the air.

4th. Between November 19, 1868, and January 31, 1869, there fell in the Torquay district no less than 1890 tons of rain on every acre of ground. Taking this as the average for the county, and supposing the mean height of the rain clouds to have been no more than 772 yards,—estimates both probably below the truth—the caloric into which the motion of the rain of Devonshire would be converted on being destroyed as

motion, during the period specified, would be sufficient to raise the temperature of 4·5 millions of tons of water from the freezing to the boiling point.

5th. But for the condition of the atmosphere which renders such a rainfall possible, the surface of the earth, in all probability, would have been frozen, and the heat of the sun would have been largely expended in thawing. Not having this work to perform, it helped to raise the temperature of the atmosphere beyond that which is usual at that period of the year.

With a machinery so multiform and efficient at hand, it does not seem needful to be for ever supposing that the Gulf Stream is guilty of some irregularity of conduct.

ON THE SUBMERGED FOREST AT BLACKPOOL, NEAR DARTMOUTH, SOUTH DEVON.

BY. W. PENGELLY, F.R.S., F.G.S.

IN a paper on the Submerged Forests of Torbay,* which I had the pleasure of reading to this Association, during the meeting at Tiverton, in 1865, I recorded the facts that a Submerged Forest existed at Blackpool, about two and a half miles south-west of Dartmouth; that it was almost always entirely concealed by the sand thrown up by the waves; that it had been described to me by persons who saw it during two brief exposures, one in July, 1802, and the other about fifty years afterward; and that there was reason to believe that it had never been laid bare during the interval, so that two generations of geologists might have traversed the strand at every low water without detecting a trace of the forest beneath them.†

The *Torquay Directory* of February 10th, 1869, contained the following paragraph:—"The fine beach, situate about midway between Stokefleming and the far-famed Slapton Ley, just now presents a most unusual appearance. The action of the heavy seas during the late tempestuous weather has entirely removed the deep bed of sand from the western end, exposing a bottom of blue clay, in which, at low water, portions of bark and nuts may be found embedded, which indicate the remains of a primeval forest which, ages ago, flourished on the spot. The place is well worthy a visit from any one interested in geological incidents."

From the description of the locality, it was tolerably certain that the forest alluded to was that at Blackpool. Believing that a shift of wind would cause the waves to restore the sand, and once more to bury this interesting but rarely-seen evidence of a change of relative level of land and sea, I started for Dartmouth the next day, February 11th, accompanied by three ladies who take a lively interest in geological phenomena. On reaching Dartmouth we found, as had been expected, that our destination was Blackpool, and that the forest was still to be seen.

* "Transactions, Devonshire Association for the Advancement of Science, Literature, and Art," vol. i. pp. 30-42.

† Ibid. p. 32.

We were so fortunate as to reach the beach at spring tide low water, and to find, admirably exposed, by far the finest example of a Submerged Forest which I have ever seen. It occupied a rectangular area, extending from the small river or stream at the western end of the inlet, about one furlong eastward; and from the low-water line, thirty yards up the strand.

The lower or seaward portion of the forest area, occupying about two-thirds of its entire breadth, consisted of a brownish drab-coloured clay, which was crowded with vegetable débris, such as small twigs, leaves, and nuts. There were also numerous prostrate trunks and branches of trees lying partly embedded in the clay, without anything like a prevalent direction. The trunks varied from six inches to upwards of two feet in diameter. Much of the wood was found to have a reddish or bright pink hue when fresh surfaces were exposed. Some of it, as well as many of the twigs, had almost become a sort of ligneous pulp, whilst other examples were firm, and gave a sharp crackling sound on being broken. Several large stumps projected above the clay in a vertical direction, and sent roots and rootlets into the soil in all directions and to considerable distances. It was obvious that the movement by which the submergence was effected had been so uniform as not to destroy the approximate horizontality of the old forest ground. One fine example was noted of a large prostrate trunk having its roots still attached, some of them sticking up above the clay, whilst others were buried in it. This tree had fallen towards the east.

Both the trunks and the soil, though carefully examined, failed to disclose any traces or indications of ancient tools. Nor was the search for bones, teeth, antlers, or, indeed, animal remains of any kind, much more successful. The only relic of this nature which was met with was a portion of a wing-case of some coleopterous insect, and this the wind carried off almost as soon as it was found.

Hazel nuts were extremely abundant—some entire, others broken, and some obviously gnawed. A few appeared to have been flattened as if from long-continued pressure. On digging into this mass and exposing new surfaces, a very disagreeable odour was emitted, which affected some of the party with nausea.

Towards the uppermost or landward margin of the area, the clay was of a bluish lead-colour, and traversed by a considerable number of rectilineal furrows, which, at first, I was inclined to regard as hollows out of which trunks of trees had been washed. This hypothesis, however, appeared to be negatived by the facts that there were no roots or, indeed,

vegetable débris of any kind to be seen in this part of the clay, and that the longest axis of every furrow was at right angles to the water-line. Hence, to suppose that they had formerly been occupied by trunks of trees, it would be necessary to suppose also that all the latter had fallen in one and the same direction; but this, as has been stated, is by no means borne out by the trunks remaining on the lower belt of the area, where they appear to have fallen towards every point of the compass. In all probability the furrows were scooped out by the waves, perhaps during previous exposures.

If a conjecture may be hazarded on the point, I would suggest that the blue clay is perhaps the substratum on which the brown clay lies, and that the latter, with its vegetable débris, has been stripped off the landward belt of the old forest ground.

It has been stated that the forest area reached the spring-tide low-water line; hence, as the greatest tidal range on this coast amounts to eighteen feet, we are warranted in inferring that the submergence amounted to eighteen feet as a minimum, even if we suppose that some of the trees grew in a soil the surface of which was not above the level of high water. There is satisfactory evidence that in Torbay it was not less than forty feet, and that in Falmouth harbour it amounted to at least sixty-seven feet.*

The means at my disposal did not allow me to bring away many samples of the forest for careful examination at leisure, but shortly after my visit I was so fortunate as to meet two gentlemen of Kingsbridge, who, with Mr. Vivian of Torquay, had also inspected the forest, and on their return kindly sent me a hamper filled with selected portions of the vegetable débris.

To the same gentlemen I am indebted for a rather small horse chesnut, which, though perhaps somewhat bright, may be said to have the forest aspect. It was found lying loose on the surface of the forest area, and may have been cast up by the waves.

Mr. A. Hunt informed me on March 23rd, 1869, that the forest had entirely disappeared. For about a week immediately preceding there had been strong north-easterly winds, sometimes becoming very heavy gales. The forest therefore could not have remained uncovered for more than a month, or five weeks at the utmost. This, however, was a long exposure when compared with those of earlier periods, according to the accounts which have reached us.

* See "Transactions Devon Association," vol. i. pp. 131 and 134. 1868.

ON THE ANTIQUITY OF DARTMOUTH.

BY DR. NEWMAN.

ORIGIN OF THE TOWN.—This, like that of most towns, is involved in obscurity. There is no doubt, however, of the extreme antiquity, if not of the town, at least of its river being deemed a safe and good harbour.

Legends have existed of the landing at Totnes of Trojans after the taking of Troy; and that would carry us back somewhere to the middle of the tenth century (B.C.); for it was not the Prince Æneas who escaped from Troy's destructive flame, but about the fourth in descent from him, who is said to have navigated the channel of the Dart.*

I imagine Totnes to be by far the older town. It appears general throughout the oldest towns on the coast of England, that they were not built on the most convenient place for shipping, but some miles up rivers whose course is difficult for strangers to navigate. Pirates being constantly on the seas at those times led to these precautionary measures. If we look at the old towns round the south coast of England we shall find this to be the case. London itself lying far inland; Bristol some miles up the Avon, with most difficult approach; Plymouth lying on the small Catwater; Devonport harbour having till modern times been neglected.

And so Totnes appears to have existed long before Dartmouth, which is undoubtedly one of the very oldest towns in the kingdom. It is most likely of Phœnician origin, and was the emporium of the tin trade of its neighbourhood.

* "I am no judge of the date of its construction. I have only one suggestion to offer: its appearance is *very, very* ancient; and as we learn from old *Stow's Chronicles of England*, printed in the 23rd year of Queen Elizabeth, that Brute, the great-great-grandson of Eneas, the founder of the Latins, about the year 1100 B.C. (which corresponds with the reign of king Solomon), '*landed at a place now called Totnes, in Devonshire.*' He must have entered the river Dart, and very glad must he have been, after his long and perilous voyage, to have dropped his anchor and furled his sails in such a safe harbour as the mouth of this river afforded him. And may he not, in thankfulness for his prosperous voyage and safe arrival at so beautiful a spot as this river must then have been, the hills wooded from the top to the very margin of the water, have offered a libation to Neptune by throwing the goblet with the precious liquor it contained into the river, where it has been wonderfully preserved in its soft bed until the present time."—*Rev. John Smart, Kingswear.*

Totnes was fortified, like ancient Rome, by cutting away the sides of the hill. It was built on the spur of a hill, connected only by one narrow isthmus; on all other sides it was surrounded by marshes and steep acclivities, with sides rendered perpendicular, the remains of which can still be traced. It was a borough before the conquest, when it had 110 burgesses.

Dartmouth has no history so old as this. One of the first things I can discover about it is, that in the middle of the thirteenth century a toll that had been paid by Dartmouth to the mayor of Totnes was then remitted. In the following century its history and importance became much more clear. Prior to this William Rufus is said to have embarked here for Normandy, and before the fourteenth century it had sent two members to Parliament, one of whom was lost on the passing of the Reform Bill in 1832, and one in 1868.

It seems to have been a place which high powers have delighted to bully; for we learn the mayor of Totnes oppressed it. The third Edward mulcted it for the benefit of his son. The Duchy officers have since that time taken all the dues they can, and spent very little if anything on the place. And finally all we have got to redress these ancient grievances is a body of harbour commissioners, who, it is said, will in time restore Dartmouth to its ancient importance.

The town of Dartmouth lies on the west side of the river, from which its name is derived, the harbour being at all times accessible to the largest ships, and so securely landlocked that at times when shipwreck has occurred in many of the neighbouring ports not a vessel has here dragged its anchor.

The advantages of the port seem by tradition and history to have been very early known. In the middle of the fourteenth century it had attained an importance second to few in the kingdom in a maritime point of view. The first charter that now exists, which gave Dartmouth the power of choosing a mayor and aldermen, was given by Edward III., about 1341. This is the time when it is supposed to have received its noble shield—a king in a boat. The older seal used by the mayor differs from the present one in this respect,—there are no lions on it. The lions are said to have been added by King Richard III., in reward for signal service rendered by the town in time of war.

It is curious to observe the relative proportions of the king and the lions in former and present times; the king in the shield is evidently bigger than the two lions taken together.

Is it that the race of kings has degenerated, or that lions have increased in size?

In Edward III.'s reign Dartmouth was strong in ships. In 1347, during the siege of Calais, it furnished 31 ships and 757 mariners, the largest number but that sent by two towns, namely, Fowey and Yarmouth. The former sent the greatest number of ships—47; the latter the largest number of men—1905. There were 84 towns in all that contributed, the last in the list being Mersey, or Merton, which sent one ship and six men only.

In 1377 the town was burnt and destroyed by a powerful army from France, and was again, thirty years afterwards, assaulted by a M. du Chastel and a French admiral. They were received in a way they did not expect; for we are told that the "townsmen and inhabitants behaved themselves so gallantly, and received the enemy with such intrepidity, that they were glad to regain their ships, with the loss of 400 killed and 200 taken prisoners, among whom were several persons of distinction, especially the Lord du Chastel, their commander."

In the fifteenth century there appears no reason, beyond the natural advantages of the port, for its commercial importance; but in the sixteenth we have a clearer cause in view. Probably some of the first or most prominent of the Newfoundland adventurers came from this place. That island was discovered in 1497, and in 1583 Sir Humphrey Gilbert, who was born on the banks of the Dart, received from Queen Elizabeth a patent conveying to him certain rights and privileges on the island. He died on his way back to England, the vessel having foundered on the banks of Newfoundland.

Dartmouth has always been intimately connected with this island, and to a certain extent is so still; and during the last century some of the largest fortunes amassed in Dartmouth were almost exclusively derived from that source.

Dartmouth does not figure in history from the time of Edward III. or Richard II. till the war broke out between King Charles and his Parliament. Dartmouth declared for the latter, and although badly situated for defence, it held out against Prince Maurice for one month and four days. The town was afterwards garrisoned for the king, and three years afterwards Sir Thomas Fairfax deemed it a place of too much importance to pass by in his way to Cornwall. Sir Thomas halted at Totnes on his way to Dartmouth, and sent two regiments from thence to take the town, which was "stormed by him in person, when it was taken, with its Castle, Town-

stal Church, Mount Boone, and Kingswear Fort, assisted by the fleet under Admiral Batten."

BUILDINGS.—There are three buildings in the town that I will briefly notice: they are S. Saviour's Church, the Castle, and the Butter-walk; the last-named was erected by a person named Hayman, in 1635, whose arms still exist in one of the houses. It consists of five houses, forming a sort of piazza, the front being supported by a row of stone pillars, on the tops of which are some of the signs of the Zodiac curiously carved. All these houses formerly communicated with each other, and it is said they were built for five daughters of the designer. The interior is full of quaint carvings and curious ceilings, and will well repay a visit.

S. Saviour's Church is the only one I can recommend strangers to visit. The one at the Castle, S. Petrox, either never had any architectural beauty, or it has been so defaced that it cannot now be seen. There exists there, however, an old Saxon font, specimens of which may be found in some neighbouring churches. It is curious how entirely different the pillars and arches are as you approach the chancel to what they are at the western end. Those which appear the more modern are very curious. The chancel and some part of the church were built by Hawley; and there is supposed to exist a deed, dated 1372, wherein the mayor and corporation agreed to keep it in order. The curiosity of the arches and pillars consists in the arches being rounded like Norman ones of far anterior date; while the pillars are a true type of the 14th century, when this part was built. The screen is very handsome, and is said by some to have been taken from a Spanish ship. It is certainly like many seen in Spain, and its colouring and that of the pulpit is quite in Byzantine style. The pulpit is of stone, and very beautiful. The iron work on the South door is a great curiosity; and is coeval with the church. The date (1639) is wrong, and it is explained in various ways. If restored with its beautifully-laid ground plan, our old church would rank high among the churches of Devon.

FORT.—The fort now at the mouth of the harbour is quite modern, though there are remains of old buildings near. There was an old office of Governor of the Castle of Dartmouth, which is now disused. The Prince of Orange when he landed at Brixham gave a warrant (still, I believe, in existence) to one Nicholas Roope to take charge of the castle on behalf of the Prince. The mouth of the harbour was further guarded by a chain stretched across it. In 1725 the

office of Governor was given to Fort-Major Arthur Holdsworth, and it continued in that family till 1860. When the late Governor died the office became extinct. The last Governor held the office just fifty years, though since 1832 no pay has been attached to the office.

With a few words about two great sons of Dartmouth I conclude; they are Newcomin and Hawley. Newcomin was an ironmonger of this town, and was assisted by a plumber of the same place named Cawley. In 1705 they took out a patent, and by 1713 had a really good working engine. It is thus summed up in Reid's work on the steam-engine: "Though now superseded by Watt's, Newcomin's engine ought never to be forgotten; and as the raw material from which Watt constructed his admirable engine, it cannot be too highly estimated. It was used exclusively for sixty-two years, and for a considerable time afterwards was much employed."

For nearly one hundred years it was the chief hydraulic machine for draining mines. The house where Newcomin lived was standing six years ago, but is now pulled down. The carving was taken out by the late Governor Holdsworth, and placed in a room at Brookhill, where it may now be seen in a very interesting state.

John Hawley was born in Dartmouth. Here he traded, and was so successful that the winds, by an old saying, were said to blow always in his favour from every quarter of the world. He is said to have got the lions put in the coat of arms of the town. About this, however, there is a doubt, as the privilege of bearing the lions in their shield was given at too early a date for Hawley to have been able to ask for them. He is said to have been asked by King Richard what reward he would have for some services rendered by him to the State, and he replied that his humble desire was, that his town might bear some badge of Royal bounty.

He was no less a soldier than a merchant, as may be guessed by his being portrayed on his tomb like a knight in armour, not in robes of peace. He was twice married, and lies buried within the chancel he built, in a tomb on which is inlaid in brass the figure of himself armed *cap-d-pie*, between his two wives, each under a very fine canopy of brass, over which were some engraved shields, long since embezzled. He was a man whose name, if it stands not high in the list of warriors, yet does so in perhaps a nobler list,—that of men who have given up private gains for the welfare and advantage of their neighbours.

STRICTURES ON MICROSCOPIC PHILOSOPHIZING.

BY JAMES JERWOOD, M.A.,

Barriater-at-Law, Recorder of South Molton, &c.

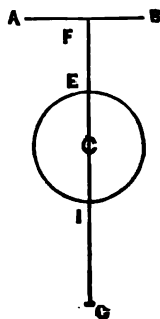
If a person were to examine an object placed at a proper distance for observation, and another person having the same distinctness of vision were to view it at a much greater distance, and a third person having the same powers of eyesight were to examine it through a microscope, and were each person to describe the object according to the impression which it had conveyed, their descriptions would all differ amongst themselves; and were they each to give their descriptions of the object without stating the circumstances under which they had viewed and examined it, their description would obviously form matter of dispute, not only among readers generally, but also amongst themselves.

Bishop Berkely says: "Take an inch marked on a ruler; view it successively at the distance of half a foot, a foot, a foot and half from the eye, at each of which, and at all the intermediate, distances there shall be more or fewer points discerned in it. Now, I ask, which of all these various extensions is that stated determinate one that is agreed on for a common measure of the other magnitudes?" In this instance, if the inch were viewed at the several distances by different persons having the same clearness of vision, its number of points would appear different to each observer; and were they each to describe the inch as it had appeared, it is quite clear that their descriptions would not agree; very probably each observer would maintain that the others were wrong, and that he alone was right.

What has been said perhaps renders it pretty manifest, that before the observers can agree in their descriptions of an object viewed, they must be brought acquainted with the particular circumstances under which it has been respectively examined, and must modify their descriptions accordingly.

The simple theory of microscopes may be thus briefly explained. If an object be placed in the focus of a convex

lens, and the eye be at a proper distance for vision on the other side, the object will appear distinct and erect, and it will be magnified in the ratio of the focal distance of the lens to the common distance of distinct vision—that is, about eight inches: or thus, suppose an object AB to be placed in the focus F of a small glass sphere, and the eye behind it in the focus G. The object will appear distinct and in an erect position; and it will, moreover, be increased in magnitude in the ratio of $\frac{3}{4}$ ths of EI to 8 inches. Let the diameter EI = $\frac{1}{10}$ th of an inch, then CE = $\frac{1}{20}$ th and EF = $\frac{1}{2}$ CE = $\frac{1}{40}$; hence CF = $\frac{3}{40}$ ∴ $\frac{3}{40} : 8 ::$ the natural size: the magnified appearance, or $3 : 320 :: 1 : 106\frac{2}{3}$; that is, the object is magnified nearly 107 times. This explanation applies to single microscopes; but it will be obvious from this simple example that this trifling difference in the power of the lens will very considerably increase or diminish the magnified appearance. The same remark applies, taking their complex construction into account, to the various kinds of compound microscopes which are generally used in philosophical inquiries.



A globular object which is less than $\frac{1}{10}$ th of an inch in diameter is to most eyes totally invisible; an object which is $\frac{1}{10}$ th of an inch in diameter subtends an angle of one minute at the distance of 8 inches from the eye: no object, therefore, less than $\frac{1}{10}$ th of an inch in diameter can be seen by *common eyes*. (*Encyc. Metrop. Optics*, p. 425.)

To the generality of eyes the nearest distance of distinct vision is, as before observed, about 8 inches, called the minimum visible. Some eyes, however, can see small objects best at the distance of 6, 4, or even 3 inches; whilst others can see most distinctly at 12 or 15 inches.

Now, suppose the above sphere to be used by each of these persons,

$$\text{then } \left\{ \begin{array}{l} \frac{3}{40} : 6 :: 1 : 80 \\ \frac{3}{40} : 4 :: 1 : 53\frac{1}{3} \\ \frac{3}{40} : 3 :: 1 : 40 \\ \frac{3}{40} : 12 :: 1 : 160 \\ \frac{3}{40} : 15 :: 1 : 200 \end{array} \right\} \text{ the magnified appearance of the object.}$$

From these very simple illustrations it will be obvious that a small object viewed by the same person through different microscopes will not appear to be the same. Also, that if the

same small object be viewed through the same microscope by two persons having eyes possessing different powers of distinct vision, it will not appear alike to each observer. Hence, if each observer describes the object as it appeared to him, their descriptions will manifestly differ. If the microscopes they employ be precisely of the same construction, and their eyes be exactly of the same formation, very probably their descriptions of the object viewed would agree. On the other hand, if their eyes are alike and their microscopes differ, or if their microscopes be the same and their eyes not alike, some modification must take place so that they may each view the object under the same circumstances before their descriptions of it can possibly concur.

It requires no formal demonstration to prove that if either of the observers were to generalize upon his observations without any explanation respecting eyesight, instruments, &c., a theory resting upon such a basis would be altogether nugatory. If, for instance, any substance has been examined, and alleged to be composed of particles of a certain form or kind, unless upon a proper examination it be found to be so made up, the allegation relative to its component parts is a matter of doubt or denial. Hence such examinations, however scientifically and carefully made, can add little or nothing to our real knowledge of the constituent parts of bodies, unless the observers also minutely detail the process by which they were examined, and all the circumstances with regard to instruments, visions, &c., connected with the investigations; so that, if the objects be viewed by other observers with the same care, and under the same incidents, they may appear to all alike. Unless this concurrence be general, any peculiarity must be attributed to eyesight, instruments, &c. The same body similarly scrutinized must always appear the same; and it would be idle to assert, that observers who differ as to the form of the component particles of bodies, by such differences at all increase our knowledge of the real intrinsic nature of such bodies. Their disputes are difficult to reconcile; they tend to impede rather than to accelerate science.

It is no easy matter to account satisfactorily for the striking discrepancies which occur in the descriptions of the constituent particles of matter, even when the authors of such descriptions are men alike accustomed to such examinations, and whose acuteness, probity, and talents are equally undoubted, unless these differences can be referred to some dissimilarity in the instruments employed, or to some unlikeness in the observer's powers of vision. But however honest

and careful each observer may be, it is evident that their differences render their labours very nearly abortive. They do not advance knowledge. It is much easier to jump to the conclusion that they are all wrong, than it is to ascertain which is right, especially if the groundwork of their descriptions be not fully and carefully explained. My talented neighbour, Dr. Shapter, in his interesting address to the Medical Association held at Leeds some time ago, relates a remarkable instance of this diversity of description.

Dr. Martin Barry had minutely investigated the blood corpuscles, and the conclusion drawn from his elaborate investigations was, that the red corpuscle is a primary nucleated cell, circular in form, flattened on its surface, and rounded at its edges, and having a diameter ranging from about $\frac{1}{800}$ of an inch to $\frac{1}{1000}$ of an inch.

Mr. Wharton Jones, in a paper read before the Royal Society, December 8, 1842, mainly with the view of combating some of the statements of Dr. Martin Barry, says that the red corpuscle consists of a vesicle or cell with thick walls, but in a collapsed and flattened state, and having therefore a bi-concave form, and, in consequence of its thick wall being doubled on itself, presenting under a microscope a broad circumferential ring, which is illumined or shaded differently from the depressed central portion according to the focal adjustment of the instrument. The account of Mr. Addison, though in some respects similar to that of Mr. Jones, differs entirely as to the origin of the diversities of shade in the ring and centre of the corpuscle. He concludes that these appearances are due to the fact of the corpuscle consisting of two elastic vesicles, one within the other. Mr. Addison states the average size of these corpuscles to be $\frac{1}{850}$ of an inch in diameter.

The reader may learn, from Dr. Shapter's condensed summary on this subject, that Dr. Barry, Mr. Wharton Jones, Mr. Addison, Mr. Wiltshire, and Dr. Carpenter, all differ in some respects among themselves with regard to the form and component parts of the red corpuscle. When doctors so disagree, it certainly is difficult to decide. Undoubtedly Dr. Barry, Mr. Wharton Jones, and the other gentlemen mentioned, were alike solicitous to describe the object exactly as it appeared, each was equally anxious to advance science upon the basis of truth. How then may this very contradictory conclusion be reconciled? They cannot be all correct; but how may the origin of their various differences be discovered? In the absence of all information on the mystery, it does appear to be extremely likely that they did not start fair; or, in other

words, that they did not all view the objects which they describe, and about the appearance of which they so strongly differ, through the same microscope, or with the same powers of eyesight; that is, they did not examine the object under exactly similar circumstances. Taking the extreme minuteness of the object into consideration, very probably a small variation in the glass or eye is sufficient to explain many of the differences between the doctors. Such variation would evidently affect the appearance of the *thick walls* or *circles* of the corpuscle; for the reader must bear in mind that the red corpuscle, whether made up of *thick walls* or *circles* is about *ten* times less than the smallest object that can be seen by the common eye.

Mr. Coddington, in his treatise on optical instruments, mentions the object-glass of a microscope made by Mr. Carey, which shows with great distinctness in every part of a large field fine striæ on the scales of a moth's wing, which are not discovered at all with large microscopes of the ordinary construction made by the best optician.

It is pretty clear that an observer using this microscope, and another equally competent observer making use of another microscope, would differ in their descriptions of a moth's wing. One would assert that it had fine striæ; the other would maintain that it had nothing of the kind on it; which observer would state the fact? Does the moth's wing actually exhibit striæ, or is there any peculiarity in the object-glass which gives it that appearance? Do microscopes always show things really in being, or do they sometimes treat us with appearances very like optical illusions? The oxyhydrogen microscope makes the animalcules in a drop of liquid appear of enormous size. It is said that a countryman once looking at them wished to be off lest they should come out. Here, no doubt, "seeing was believing;" but the astonished observer did not think on the absurdity of such monsters being enabled to gambol in a drop of liquid.

Whether the fact quoted from Mr. Coddington's book, or the remarks upon it, will suggest any explanation of the differences among the doctors, is a question which must remain unanswered: the enigma cannot easily be solved. The doctors themselves should so far agree as to set about tracing their disputes to their first cause. One fact is certain—the doctors' differences do not advance general knowledge, even among the members of their own profession. Dr. Shapter's publication before referred to was written for the purpose of placing before the association the exact state of medical

science. With this view, having carefully stated the opinion of each theorist with respect to the red corpuscle, the doctor very justly says: "Between this conflicting testimony it is difficult to decide, and the matter must be left for further investigation." Instead, therefore, of laying before the association a statement of settled and useful facts upon the subject, the doctor, with all his care and research, could only serve them with a string of contradictions. Now if the red corpuscle of the blood be made up of certain component parts of definite forms, those parts and forms must appear alike to all competent observers, if examined under the same circumstances with regard to instrument and eyes. It is absurd to say their constituent parts are understood, if they do not appear invariably the same. Dr. Shapter's conclusion proves that the conflicting opinions of the doctors renders their labours almost useless, either in a scientific or a professional point of view. Their differences establish nothing, but they excite doubts, not as to which is right, but whether they are not all wrong. One learned set of men say "Aye," and another equally learned set say "No," and they leave it quite uncertain whether the ayes or the noes have it, or whether either ought to have it. But obviously no knowledge worth a straw can be based upon such a doubtful foundation.

That learned men should expend their valuable powers on such dubious speculations without at the same time tracing their course so that others may track and follow them, is not only unaccountable, but to a certain extent it is mischievous. This opinion perhaps requires some explanation, and it shall be attempted without referring to another topic.

Dr. Barry has published several elaborate articles on *Embryology* in the *Philosophical Transactions*; the investigations have evidently cost the doctor immense labour, and they are considered so meritorious by the Council of the Royal Society as to obtain one of their medals—the highest guerdon that a British philosopher can gain. In these essays Dr. Barry advanced the theory with regard to the red corpuscles of blood which has been adverted to above. Mr. Wharton Jones, in the same celebrated publication, has taken the opposite side of the argument, whether to gain a prize, or mere celebrity, does not appear, but at all events he manfully combats Dr. Barry's statements, and makes it very doubtful indeed which is correct, or whether both may not be wrong. Now the *Philosophical Transactions*, being a national work of the highest repute, every scientific Englishman would see them if he could. There are lovers of science who may be

fairly termed *countryfied philosophers*,—men whose love for science is great, but whose pecuniary means are small. Many such men, by carefully husbanding their incomes, contrive to purchase the *Transactions* as a mental treat: of course they read the *whole*—they cannot afford to miss anything—and they naturally infer that all they find therein is of the first water.

The very laborious physiological essays referred to have filled a large part of many numbers. No doubt they are particularly interesting to professional readers, but to the sort of reader above mentioned, it requires a mind well made up to get through them, however great the thirst for knowledge may be. To many non-professional readers, the wading through such masses of blood corpuscles, arteries, &c., is very like taking physic when one had rather not. But a reader of the description named having gone through the task of reading those articles, and having, as he thought, added to his knowledge the fact that red corpuscles are of a certain formation—how very much annoyed he must feel, in perusing a similar article in the next number, to find, in strong terms, that his fancied acquisition of knowledge is all moonshine—that blood corpuscles are not of the form first fixed on his mind, but of some other—or of no form at all. Is it not to be regretted that a reader of this class should be entrapped by the repute of the publication thus to throw away his time and money? Had they been tempted to meddle with the lumber parts of the *Lancet*, they would have no right to complain, but unquestionably the rulers of British science should have some regard for readers who buy books to read, and not merely to fill shelves. The writer has a strong fellow-feeling for this kind of readers, and he can speak positively as to the effect which such contradictory theories have on their minds: on this account, therefore, he trusts that the preceding strictures are pardonable. The suppositions as to how those learned gentlemen have arrived at their very opposite conclusions are mere conjectures, and nothing more; but if they are not satisfactory to writers who philosophize on bare seeing, they will perhaps feel the propriety of solving the puzzle themselves. If they do this the writer's object will be accomplished. No attempt to theorize has been made; the writer in some of his suppositions may be right, but this is a matter of indifference; it may be easy to show that many of his hypotheses are founded in error or misconception, but this also is of no importance; his aim is not that any one should take the trouble to prove his notions right or wrong, but to

call attention to conflicting theories, the publication of which he thinks he has shown to be useless, even to professional readers, and certainly they are of no kind of service to any one besides. It would ill become the writer, and be directly against his wishes, to speak lightly of the promoters of science. The learned doctors already named want no praise from him for their scientific achievements: he trusts that they will continue their praiseworthy exertions; but at the same time he wishes to express a decided opinion that conjectural hypotheses on subjects entirely professional, however elaborate, would be more appropriate in publications altogether devoted to such discussions, than in works adapted and intended for general readers. However, if the learned doctors will not concur in the fairness of this opinion, they as a body have the power to decide and act accordingly; but at any rate it is hoped that hereafter they will *start fair*. In the case that has been discussed, they only agree to dispute. Merrick's "Chameleon," in the following lines, speaks so closely to the point, that he almost seems to have addressed the doctors prophetically:

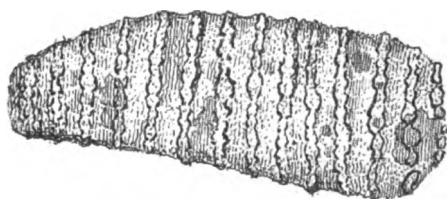
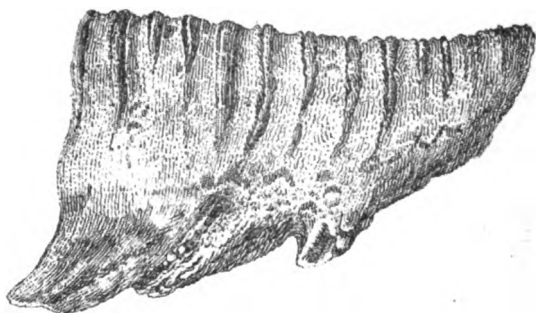
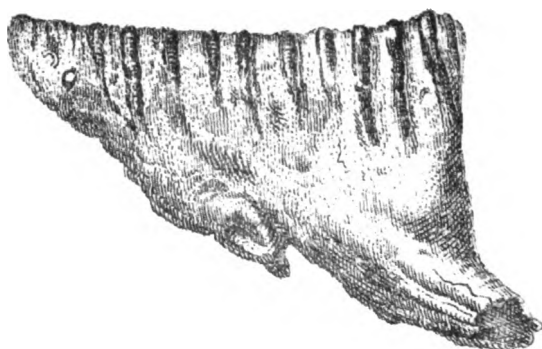
"My doctors," the Chameleon cries,
 (When first the creature found a tongue),
 "You all are right, and all are wrong.
 When next you talk of what you view,
 Think others ~~are~~ as well as you;
 Nor wonder if you find that none
 Prefers *your eyesight* to *his own*."

What microscopic philosophers see, or pretend to see, are realities or imaginary objects; they describe facts or fallacies. If they write about real entities, their descriptions of them ought to be alike, and when they differ, strong doubts must arise as to which delineation is correct, and the reader, who is incompetent to repeat the necessary experiments to get at a decided proof, and who does not know enough of either of the disputants to fix his faith to what he asserts, naturally concludes that the whole is too imaginary to be of any service, or to establish any fact. Such labours, wherever published, if they were properly classified, must come under the denomination of exceedingly useless philosophizing, or very learned trifling,—well adapted to disappoint the *countryfied philosophers*, and fit only to increase the bulk of a publication without in the smallest degree adding to its credit.

Although the construction of microscopes and their application to philosophical inquiries have recently obtained much attention, still it is thought the same readers will not consider the preceding remarks entirely out of place.

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TOOTH OF FOSSIL ELEPHANT.

FOSSIL ELEPHANT'S TOOTH.

BY P. O. HUTCHINSON.

(*Local Secretary to the Society of Antiquaries of London.*)

On the 19th of March, 1869, a sailor brought me at Sidmouth a fossil elephant's tooth. As the sailors and fishermen frequently bring objects which they dredge up—sometimes of a worthless kind, which they recommend as curiosities—I received him with some reserve. He told me he had procured it from the bottom of the sea, at low water spring tide, at the latter part of the preceding month of February. It was full moon on the 26th, and he obtained it on the first or second day after, but was not certain which. This occurred opposite “Wind-gate,” as the depression between Peak and High Peak Hills is called, and at about a mile or a mile and a quarter west of Sidmouth. He further added that a stranger, who had seen the object in his hand, had offered him four shillings for it, but that he would not close any bargain until he had first shown it to me, as I had bought things of him before, and feeling assured that it was a curiosity, he would not part with it under five. Though at first sceptical in respect of his story, I recollected that in the Torquay Museum there is the last lower left side molar of a mammoth, dredged up some years ago from the bottom of Torbay, and I thought it better to accept his offer, and secure the tooth at once. The height of the tooth from the root is five inches and a half, the crown is seven long and three wide, and the weight is four pounds. The colour is ochre, and various shades of reddish-brown, the hard ridges on the crown, extending partly down the sides, being black. Unlike the Torquay specimen, which does not appear to have lain long unburied at the bottom of the sea, as it is free from the attacks of marine polyzoa, this one is in several places incrustated with serpulæ and corallines. On submitting a coloured rubbing of the tooth to Professor Owen, at the British Museum, he was disposed to consider this as the fifth in succession, lower jaw, of the *Elephas indicus*, or of a species allied to it; that it had been much worn; and that it had been shed. But bearing in mind that the learned professor has not seen the original, we must be cautious not to fix upon him too confident an opinion. I destine this specimen to the Exeter Museum.

ON EXTRAORDINARY AGITATIONS OF THE SEA NOT PRODUCED BY WINDS OR TIDES;

WITH A REFUTATION OF THE NEW THEORY THEREON.

BY RICHARD EDMONDS, PLYMOUTH.

(Communicated by C. SPENCE BATE, F.R.S., etc.)

ALTERNATING currents of the sea not produced by winds or tides have often been observed rushing out and in on our shores, falling and rising generally from two to six feet below and above the proper level of the water, and occupying in each efflux, as well as in each influx, from three or four to six or eight minutes; and they are always accompanied with earthquakes, thunderstorms, great maxima of the thermometer, or considerable minima of the barometer, and sometimes with all these together. Well known instances were observed on the day of the great earthquake of Lisbon in this and in other countries of Europe and Africa, and in the West Indies. Such as take place in the *absence* of known earthquakes are in all respects similar to those *simultaneous* with known earthquakes, so that the popular voice has always attributed them to earthquakes, either observed or unobserved. Scientific men, however, on both sides of the Atlantic, finding that they are generally attended with great thunderstorms, have ascribed them (when unaccompanied with *known* earthquakes) to mere atmospheric causes.*

Having witnessed one of these agitations in Mount's Bay on the 5th of July, 1843, I wrote a description of it in the *Literary Gazette* of the 15th of that month, from which Mr. Milne has quoted largely in his elaborate paper on the subject, read before the Royal Society of Edinburgh in February, 1844.† In my paper read before the Royal Geological Society of Cornwall in October, 1843,‡ I ascribed them to submarine earthquake shocks occurring in the locality of the agitated

* "Edinb. Phil. Trans.," xv. pp. 621, 635; "Silliman's Journal," quoted in the "Edinb. Phil. Journal" for January, 1847.

† "Edinb. Phil. Trans.," vol. xv. pp. 609-638.

‡ "Transactions of Royal Geological Society of Cornwall" for 1843, p. 117.

waters. They have recently, however, been ascribed (but without sufficient reason, as I shall presently show) to submarine earthquakes thousands of miles away from the observed disturbances.

My own hypothesis requires for its support nothing more than a mere vertical shock or vibration of the bed of the sea, without any earth-wave, upheaving, subsidence, dislocation, or fracture of the submarine ground. Such a shock, when received by a horizontal plane of the bed of the sea, would be transmitted upwards through the sea as through a solid body, and with much greater rapidity than the swiftest flight of a cannon ball. On reaching the surface of the water, that surface would be dashed up vertically; and if a ship were on the spot it would receive the shock, and rise many inches above her water line and then fall as many below it, and thus continue rising and falling perpendicularly until the equilibrium were restored. If loose pieces of timber or anchors were lying on the deck, the shock would be transmitted to them, and they would be jerked up to heights proportioned to the violence of the shock. On one occasion, 40 leagues west of St. Vincent, the men were thrown "a foot and a half perpendicularly up from the deck," just as during the earthquake in Calabria in 1783, masses slightly adhering to the ground bounded into the air to the height of several yards, and in some towns a great part of the pavement stones were thrown up and found lying with their lower sides uppermost; or, as during the earthquake of 1797 in Peru, which destroyed the town of Riobamba, some of the inhabitants were dashed up hundreds of feet from the ground. If a vertical shock, instead of proceeding from a horizontal plane of the sea-bed, were to proceed from the inclined plane of a submarine mountain, and a ship were sailing towards it, the shock would be transmitted through the sea as through a solid body in lines at right angles to that inclined plane, and would dash off the superficial water at the same angle, and might reach the ship with sufficient power to arrest her progress, and make all on board believe she had struck on a rock, instances of which are on record.

What I have just stated will help to account for the extraordinary oscillation of the sea at Penzance on the day of the great earthquake of Lisbon, as recorded by Borlase.* At the mouth of Penzance pier the depth at low water is one fathom, which gradually increases towards south-east and south-south-east (the most open part of Mount's Bay) until at the distance

* "Phil. Trans." xlix. p. 373.

of two miles it becomes 18 fathoms. Now if a portion of the bed of the sea extending a mile or two outside the pier towards the south-east and south-south-east were to receive a violent shock vertically from the interior of the earth, a *surface* of sea of equal extent would instantly be dashed with great velocity towards the south-east and south-south-east, and if the shock or vibration were repeated ten times a second for half a minute (as is common in earthquakes), a fresh *surface* of water would be dashed seaward by every successive vibration, until at length a considerable quantity of water would be driven seaward, forming a very broad, but not high, wave. To replace the water thus dashed *seaward*, there would be a rapid efflux from the north-west and north-north-west, leaving the harbour of Penzance almost dry. When the shock ceases the dashed off waters return *shoreward* to find their level, the reflux being from the south-east and south-south-east (as was the case there on the day of the Lisbon earthquake), and the alternating current moves up and down the shore like the oscillation of a pendulum until the equilibrium be restored. That an earthquake "shock" *does* generally consist of a rapid succession of countless vibrations is evident, not only from its being felt *at sea* "like the letting out of a cable," and on *land* "like a waggon rushing over a paved road," but by its very names of earthquake, *tremblement de terre*, and *σεισμος*. The example now given is a fair type of this phenomenon; occasionally, however, during these oscillations, especially when of long continuance, they become of greater magnitude at one time than at another—which may result from a subsequent more violent shock producing a greater efflux. This varying magnitude of the phenomenon was noticed, not only during the extraordinary and long-continued agitations of the sea in Australia and New Zealand* some hours after the great earthquake in Peru of the 13th of August, 1868, to which I shall have presently to refer, but also in the equally memorable and long-continued extraordinary disturbances of the sea in the Scilly Isles, Mount's Bay, Falmouth, and Plymouth, on Whitsunday, the 23rd of May, 1847. That in Mount's Bay was noticed as early as 5 a.m., and continued all day with *varying magnitude*, the rise and fall having been from three to five feet or more perpendicularly. The maximum in Mount's Bay was at 5 p.m., and in Plymouth between 8 and 9 p.m. In the night preceding, a slight tremor of the earth was felt in Mount's Bay by two coastguardsmen while standing on the

* See the *Times* of 2nd December, 1868, in its own correspondent's letter from Melbourne.

cliff between Newlyn and Mousehole, and a "strange noise, as if underground, was heard" at Scilly about the time of the oscillation there.* So likewise in New Zealand, at Christchurch, a slight shock of an earthquake was felt about an hour and a half before the commencement of the agitation of the sea in Lyttleton Harbour.

Many consider these agitations on sea shores to be owing to corresponding disturbances in the offing. But although there may be, and doubtless often are, at the same time analogous disturbances far off at sea where submarine hills or mountains have inclined sides like our inclined shores or coasts, yet all of them, whether far off or on shore, are perfectly independent of one another, and the disturbed waters never extend far from that particular part of the bed of the sea over or near which they had previously rested. Those, for instance, observed in Portleven, Marazion, Penzance, and Newlyn,—all in the interior of Mount's Bay—have been always independent of one another, and neither before nor during their occurrence is any disturbance whatever perceived seaward beyond the distance of a few furlongs from either of these places. So likewise when similar agitations have occurred in the creeks or branches of Falmouth harbour, no kind of disturbance has ever been noticed at the mouth of the harbour, either before or during their occurrence.

Perfectly similar disturbances take place also in inland lakes when their beds receive vertical shocks. For example, on the day of the second great earthquake of Lisbon, in 1761, the waters of Lockness "swelled up like a mountain," by which expression I understand that the waters resting on its inclined shores were, by the vibrations of a subaqueous shock, driven off towards its centre, and there accumulated to an astonishing height. A similar phenomenon occurred in Lake Ontario on the 20th September, 1845, when, during a tornado and thunderstorm, with waterspouts and large hail, the waters suddenly moved "in a mass out of the rivers, bays, coves, harbours," &c., to a depth of two feet, and then returned to an equal height above their previous level. As this happened simultaneously on both sides of the lake, a great elevation must thereby have been produced at or near the centre, as was the case at Lockness.

Having thus described the effects produced in bays and lakes by subaqueous earth-shocks, let us now consider how such shocks would act on a canal. They would not only

* "Penzance Nat. Hist. and Antiq. Society's Report," vol. i. p. 171.

drive the water from the sides of the canal towards the centre, where it would rise into a long ridge, but would at the same time drive the water from its higher towards its lower end. This latter water when its momentum ceased would flow back to the higher end, where, rising to a much higher level than it had before, it would dam back any stream gently entering there. All this was exemplified in the Surrey canal on the day of the Lisbon earthquake. That canal was 700 feet long and 53 broad. "The water at its higher end usually pens from two to four feet, growing gradually deeper to the west end, where it pens to about ten feet. At or near the higher (eastern) end the ridge of water raised in the centre was about 90 feet long, and between two and three feet above the usual level: this ridge heeled northward, and flowed over the walk on the north side of the canal. On the waters returning into the canal another such ridge was raised in the middle, which heeled southward, and flowed over the walk on the south side. During the second movement the small stream at the higher end, which constantly flowed through the canal, was driven back 36 feet towards its source. This driving back of the stream was ascribed* to the second movement from side to side; but I do not see how any movement from *side to side* could have increased the depth at the higher end, where the stream entered. It was evidently the second movement *from end to end* that dammed back the stream; for it must have then reached the higher end of the canal, and made the water there not less than twice as deep as it was before, so as to drive back the stream. The oscillations from end to end no doubt escaped observation on account of the far more striking oscillations from side to side.

Some persons question whether submarine or subaqueous shocks ever occur *near* dry land without occurring also *on* the dry land. It is true that in South America these agitations of the sea are generally accompanied with known earthquake shocks, extending often (according to Acosta) 200 or 300, and sometimes even 500 leagues along the coast,—which shocks in Chili, Peru, and Terra Firma (according to Humboldt) follow the course of the shore, and extend but little inland. In Europe, however, the shocks which produce these disturbances of the sea are not generally felt at all on the neighbouring dry land. The extensive shocks now referred to beneath the sea, and on the neighbouring shores of South America, are probably vertical or nearly vertical shocks proceeding from great depths of the earth, since they are

* "Phil. Trans." xlix. p. 364.

felt almost at the same instant over tracts of land extending some hundreds of leagues as if they had radiated from a distant centre; but although reaching upwards to the seabed, and even as high as the sea-shores,—the lowest parts of the dry land—they have not power to attain higher levels. “In the mines of Saxony,” says Humboldt, “we have seen workmen hasten up affrighted by oscillations not felt on the surface.”* So in England, on the day of the great earthquake of 1755, out of five smart shocks felt 60 fathoms underground in Derbyshire Peak, only one was felt on the surface; and many shocks on that day, no doubt, reached as far upwards as the bed of the sea and the basins of lakes and ponds, occasioning extraordinary disturbances of the waters, and yet most of them fell short of the surface of the adjoining lands.

Connected with the question, whether all the shocks referred to in the last paragraph are or were vertical or not, is the following remarkable fact mentioned by Mr. Mallet. The agitations of the sea now under consideration have “never been observed to take place in any earthquake whose centre of impulse was inland however violent.”† This, I consider, may be owing to the centre of impulse when inland being generally close under the surface, so that the shocks must then travel horizontally or nearly so, and it is not to horizontal but to vertical shocks that I have ascribed these disturbances of the water.

Another fact not less remarkable is, that while earthquakes in general are said to take place equally in all states of the atmosphere, those which are known only by the extraordinary agitations of the sea or lakes which they produce, occur almost exclusively during storms, or at or near considerable minima of the barometer. Is it because these latter—these subaqueous earthquake shocks—are always vertical or nearly so, whilst shocks on dry land are generally horizontal? For *vertical* shocks may be accompanied with electrical disturbances or discharges between the earth and the atmosphere, which might occasion the attendant storms or minima of the barometer, whilst in *horizontal* shocks no such electrical disturbances may be produced. The earthquake shocks felt by Humboldt in Cumana during a severe thunderstorm were probably vertical ones. “At the moment of the strongest electrical explosion were two considerable shocks of an earthquake;” but the barometer, which had been previously falling, continued to fall for five hours afterwards, when a third and

* “Personal Narrative,” vol. ii. pp. 222, 224.

† “British Association Reports,” vol. xx. p. 46.

last shock occurred, at which "moment the mercury was precisely at its minimum height."*

The extraordinary agitations of the sea in different parts of New Zealand and Australia, which commenced some hours after Iquique had been inundated by a terrific sea wave, have been recently ascribed to a "long flat swell"† originating from a submarine earthquake near Peru, and moving onward in all directions, according to the laws of ordinary sea waves, until it reached New Zealand and Australia. But no proof is given of the possibility of a sea wave originating in this manner being propagated to such a distance. Moreover this *imaginary* "great sea wave of translation," which no one has ever seen, is *likened* to the "Atlantic tide wave," although the two waves are most strikingly *unlike* each other both in *origin* and in *action*.

The *tide wave* is originated and moves on by a power continuously and directly operating on every part of it. The *imaginary wave* is originated and driven on by a *vis a tergo* not lasting, except in its effects, longer than the earthquake.

The *tide wave* in its action visits regularly every locality in its progress. The *imaginary wave* is very capricious in its visits, and although spreading in all directions, sometimes as far as from Europe to the West Indies, or from Japan to California, or from Peru to Australia, leaves undisturbed just as many seaports as it disturbs. Moreover, in the places which it *does* visit, if it were like the tide wave it would flow up the shore the moment it reached it; but this ideal wave must wait for a retirement of the sea before it can flow up the beach,—a retirement, be it remembered, not for a second or two, like the water on the sloping margin of a still river, which retires or goes out to meet and form part of the approaching little waves made by a steamboat,—but a retirement or rapid ebbing continuing generally, as already stated, from three or four to six or eight minutes.

This very fact, universally acknowledged, of such retirement of the sea being generally, if not always, precedent to its influx on these occasions, should have led to an inquiry as to the cause, *not* of the first *influx*, but of the first *efflux*, and then persons would never have gone thousands of miles off in search of it.

* "Personal Narrative," vol. iii. pp. 316-318.

† See the Articles on Earthquakes in the *Times* of 3rd November, 1868, and in the "British Quarterly Review" and "St. Paul's Magazine" for January, 1869, and in "Blackwood's Edinburgh Magazine" for July, 1869. See also an article by Mr. Mallet in the "Quarterly Journal of Science" for January, 1864, p. 68.

Let us now listen to the following brief narrative of the complete destruction of Iquique by a great sea wave immediately after the earthquake shock which had laid it in ruins, and then let us endeavour to account for this wave.

Previously however to this great wave, and "immediately after the shock, the sea was observed to be unusually high, having risen four feet above high water mark, but gently so as to do no damage. Suddenly it receded, uncovering the bay at Iquique to the depth of four fathoms, and then followed the influx of another wave, seen to approach from the open sea, a mass of dark blue water 40 feet high, which rushed over the already ruined city, sweeping away in its return every trace of what had been a town."—"At Iquique one spectator saw the whole of the surface of the sea rise, as if a mountain side actually standing up, and ran for his life to the Pampa. Too late. The waves swept him and all that was once Iquique towards the Pampa, and then back into the bay, and again thrown back to the Pampa."

This description of the destruction of Iquique in 1868, is precisely similar to that of the destruction of Callao in 1747. "The man who escaped, standing on a fort which overlooked the harbour, saw the sea retire to a great distance and then return like a vast mountain. He heard a cry of *Miserere* rise from all parts of the city, and then in a moment all was silent. Where the town had once flourished *there* was a wide sea." The same description is given of the destruction of Callao, 60 years before, in 1687. "The sea first retired and then returned in a mountainous wave." So too on the day of the great earthquake of 1755, when the sea at Madeira rose at half-ebb full 15 feet perpendicularly above high water mark. The rise was there, as well as in Lisbon and several other place, preceded by a retreat of the sea.

Now in accounting for the *first gentle retirement* and the *first gentle rise* of the sea at Iquique (for although the latter only is noticed, it was no doubt preceded by the former), I need only refer to the general explanation I have already given of this phenomenon. With regard to the *second retirement* and the *second rise* of the sea, which occasioned such terror and destruction, I must make the same allowance for the terrified spectator's imagination that I did for the imagination of the person who described the waters of Lockness, on the day of the great earthquake of 1761, as having "swelled up like a mountain." With this allowance, I consider that the second retirement of the sea in the bay of Iquique, to the astonishing depth of *four fathoms*, was produced, like the first, by sub-

marine vertical shocks of the inclined sea-bed descending from the shores of the bay—from its inner shore, and from the shores of its opposite arms. The waters thus dashed off from its inner shore would not only themselves rush *seaward*, but would also carry much of the waters dashed off from the lateral shores *seaward* with them; and as the submarine shock during this *second* efflux must have been eight or ten times more violent than the shock which produced the *first* efflux—so violent indeed and long-continued in its vibrations as to have driven most of the water in the bay to its very mouth, where it rose up “as if a mountain side standing up,” the return of this accumulated water *shoreward* to find its level as soon as the shock ceased would necessarily have inundated the city.

Having thus shewn that in these extraordinary agitations of the sea, the magnitude of the influx is in proportion to the magnitude of the preceding efflux, and that the magnitude of this efflux depends on the violence and duration of the sub-aqueous shock occasioning it, and having also shown that these agitations occur in land-locked lakes precisely as they do in bays and harbours open to the sea, it is evident that the imaginary wave coming in from the offing has no existence, and that what the terrified spectators at Iquique and Callao fancied to be such was nothing more nor less than the waters which had, by a terribly violent and long-continued shock, been *driven seaward* and heaped up to an astonishing height, *returning shoreward* when the shock was over to find their ordinary level.

Nos.	STATIONS.		Distance and Direction of the Centre of Dartmoor.	RAIN GAUGES		
				Diameter in inches.	Height above the Ground in feet and inches.	
1	Bovey Tracey	...	F 11 miles, W.	5	0 6	1
2	Chagford	...	E. 6.5 " S.W.	5	0 5	2
3	Prince's Town	...	W. 4 " N.E.	5	0 2	3
4	Mount Tavy	...	P 10 " E.N.E.	5	0 6	4
5	Tavistock	...	P 11 " E.N.E.	8	20 0	5
6	Endsleigh	...	V 17 " E.	5	0 6	6
7	Ham	...	P 17.5 " N.E.	5	3 0	7
8	Plymouth	...	P 18 " N.E.	5	30 0	8
9	Saltram	...	P 16 " N.N.E.	5	0 3	9
10	Ridgeway	...	P 15 " N.N.E.	5	0 6	0
11	Ivybridge <i>a</i>	...	B			1
12	Burton	...	B 24 " N.	5	2 0	2
13	Kingsbridge	...	B 23 " N.	5	0 6	3
14	Lupton	...	T 22 " N.W.	12	3 2	4
15	Torquay	...	T 19 " W.N.W.	5	0 9	5
16	Highweek	...	E 13 " W.N.W.	5	1 6	6
17	Bishopsteignton	...	E 17 " W.N.W.	5	6 6	7
18	Teignmouth	...	E 19 " W.N.W.	5	0 6	8
19	Dawlish <i>a</i>	...	E			9
20	Budleigh Salterton	...	E 26 " W.	5	4 0	0
21	Sidmouth	...	E 30 " W.S.W.	5	0 6	1
22	Broadhembury	...	E 32 " S.W.	5	1 6	2
23	St. George's Cyst	...	E 22 " S.W.	5	1 3	3
24	Exeter	...	E 19 " S.W.	6	44 3	4
25	Bramford Speke	...	E 21 " S.W.	5	0 3	5
26	Hele	...	E 25.5 " S.W.	8	0 6	6
27	Clyst Hydon <i>a</i>	...	E			7
28	Bradninch <i>a</i>	...	E			8
29	Tiverton	...	E 28 " S.S.W.	6	0 3	9
30	Cove	...	E 32 " S.S.W.	11	0 4	0
31	Meshaw	...	B 19 " N.	8	0 6	1
32	Castle Hill	...	B 12.5 " N.	12	3 5	2
33	Bratton Fleming <i>a</i>	...	B			3
34	Barnstaple	...	B 7 " W.	8	0 6	4
35	Northam	...	B 1 " W.	5	1 0	5
36	Buckish	...	B 5 " N.	5	1 1	6
<i>a</i> No returns for 1868.			<i>c</i> Including Prince's Town.			<i>c</i>
			<i>d</i> Excluding Prince's Town.			<i>d</i>
1	2		4	5	6	27

THE RAINFALL IN DEVONSHIRE DURING 1868.

BY W. PENGELLY, F.R.S., F.G.S., ETC.

IN accordance with the intention expressed in my paper on "The Rainfall in Devonshire during 1866 and 1867," published in the Transactions of the Association for last year,* I beg to lay before the meeting the following tables, containing the statistics of the Rainfall of our county during 1868, which have been mainly derived from Mr. G. J. Symons's *British Rainfall* for that year.

TABLE I is arranged on the same principle as that which was employed last year, and is devoted exclusively to Devonshire. It consists of 27 columns, numbered at the bottom, and forming three distinct Parts or Divisions. The first part, extending from the second to the seventh column inclusive, contains the data connected with the Stations and Gauges; the second, from the eighth to the thirteenth column, shows the rain statistics for 1868; and the third, from the fourteenth to the twenty-sixth column, those of the mean annual rainfall during the three years 1866, 1867, and 1868.

Stations:—The Stations are the same as those in Table I. in the former paper. Unfortunately, no returns have been sent in from Ivybridge (No. 11), Dawlish (No. 19), Clyst Hydon (No. 27), Bradninch (No. 28), and Bratton Fleming (No. 33); hence the horizontal lines opposite them are necessarily blank. It was thought best still to retain them in the Table, partly to facilitate comparison, and partly in the hope that information may be obtained from them in future.

Gauges:—The Gauges are the same as were used in 1866 and 1867, with the single exception of that at Castle Hill (No. 32), where, instead of that of four inches in diameter, one of twelve inches has been introduced.

* "Trans. Devon. Association for the Advancement of Science, Literature, and Art," 1868, vol ii., pp. 560-577.

Height above the Ground.:—At three of the stations changes have been made in the height of the gauge above the ground. At Plymouth (No. 8), it is now thirty feet instead of forty, as formerly; at Burton (No. 12), it is now two feet instead of thirty and a half; and at Cove (No. 33), it is four inches instead of ten inches. The last change is perhaps comparatively unimportant. The gauge, however, was formerly at a very satisfactory height, and it may be doubted whether it is now high enough to prevent drops of rain from being reflected into it from the ground. The change at Plymouth is in the right direction, but even now the height is much too great to render the returns of much, or, perhaps, of any value for determining the rainfall in comparison with that at other places. The Burton alteration is much more satisfactory, but it might still be lowered a foot or more with considerable advantage. To be perfectly trustworthy, all the gauges should be at precisely the same height—say nine inches—above the ground, and the surface should be tolerably flat for some distance around them.

Height above the Sea.:—The heights of almost all the stations above the sea remain as before. The only changes are at Burton (No. 12), St. George's Clyst (No. 23), and Northam (No. 35). At the first, the gauge has been removed from 120 to 200 feet above the sea level; at the second, from 80 to 50 feet; and at the third, from 166 to 173 feet.

The Rainfall in 1868.:—It is shown at the foot of the eighth column that the average rainfall of the county during 1868 was 43·71 inches, or 41·21, according as the heavy return from Prince's Town (No. 3) is or is not included. The same column shows that Prince's Town received the greatest, and Hele (No. 26) the least fall, the former being to the latter as 77·65 : 30·09 = 100 : 39; that the greater county average was exceeded at twelve stations, but was not reached at the remaining nineteen; that the lower average was surpassed by fourteen stations, whilst seventeen fell below it; that, with the exception of Plymouth (No. 8), Burton (No. 12), Kingsbridge (No. 13), and Tiverton (No. 29), all the comparatively dry stations lie on the east of Dartmoor, and between the parallels of its northern and southern points, whilst the wet stations are beyond these limits; that the stations high above the sea level had comparatively heavy rainfalls; that the gauges high above the ground received comparatively small amounts of rain; and that certain of the returns appear to be somewhat anomalous.

The effect of height above the ground is well brought out in the cases of Tavistock (No. 5) and Plymouth (No. 8). At the two stations comparatively near Tavistock—Mount Tavy (No. 4) and Endsleigh (No. 6)—the falls were 60·15 inches and 58·44 respectively, and, therefore, averaged 59·295. Hence Tavistock reported a rainfall 9 per cent. below that of the district in which it is situated. The explanation is seen in the fact that its gauge is 20 feet above the ground, whilst those at Mount Tavy and Endsleigh are each six inches only.

Again, the rainfall reported at Plymouth in 1868 was no more than 40·37 inches, whilst at Ham (No. 7), Saltram (No. 9), and Ridgeway (No. 10)—stations in its vicinity—it was 46·58, 48·50, and 50·77 respectively, and averaged 48·62 inches. Hence Plymouth, in the return she makes, appears to acknowledge no more than 83 per cent. of the rain which falls on the district of which she is the centre. This spurious advantage she apparently derives from the fact that her rain-gauge is 30 feet above the ground, whilst those at Ham, Saltram, and Ridgeway are three feet, three inches, and six inches respectively. It may be further remarked that of these three stations also, that at which the rain-gauge is highest above the ground, has the smallest rainfall; and, likewise, that the 20 feet elevation of the gauge at Tavistock appears to be attended by a rainfall error of 9 per cent., whilst the 30 feet at Plymouth entails an error of 17 per cent.; in other words, the error is greatest when the elevation is greatest.

The results registered at Burton (No. 12) also, are not without instruction. In 1867, the gauge at this station was 30·5 feet above the ground, and the rainfall was no more than 67 per cent. of the average of that of the county, Prince's Town being excluded. In 1868, the gauge was lowered to two feet above the ground, and the rainfall rose to 87 per cent. of the county average for the same year.

The following may be noticed as among the anomalies which have been alluded to:—Burton (No. 12) and Kingsbridge (No. 13), and especially the former, are comparatively dry stations, whilst, from their positions, they might have been expected to be wet ones. Lupton (No. 14), on the south side of Torbay, had, in 1868, as much as 8·5 inches more rain than Torquay (No. 15), on the northern side of the same inlet; yet these stations are equally near the sea, and exactly the same height above it. Exeter (No. 24), with its gauge 44·25 feet above the ground, receives the full amount of rain due to the district, so far as can be judged from the returns at the neighbouring stations of Brampford Speke

(No. 25) and St. George's Clyst (No. 23), where the gauges are no more than three, and fifteen inches above the ground respectively. During 1868, the rainfall at Buckish (No. 36) was to that at Northam (No. 35), a very few miles distant, and at almost the same short distance from Barnstaple Bay, as 4 to 3; yet their gauges differed no more than one inch in their height above the ground, and that inch was in favour of a greater rainfall at Northam.

Irregularities, like the foregoing, probably present themselves annually, and, unless they are found in the averages obtained from observations extending over a great number of years, it would be idle, in the present state of Meteorology, to attempt their explanation. It may be possible, however, to offer some elucidation of the case last mentioned. Buckish is 550 feet above the sea, Northam no more than 173 feet; the wet, or south-westerly wind must pass over the former to reach the latter station, and in the passage over the high ground the atmosphere is wrung comparatively dry. These facts, perhaps, will account for a large part, if not the whole of the difference in the two returns.

The rainfall at each station in relation to the average of that of the *entire* county is shewn in the ninth column; and in relation to the county with Prince's Town (No. 3) excluded, in the tenth column. Thus, the fall at Bovey Tracey (No. 1) was to that of the county as a whole as 112 to 100, and to that of the county omitting Prince's Town as 119 to 100; being 12 and 19 per cent. above the county means respectively, and so on for the other stations.

"Wet Days."—The eleventh column shows the number of wet days, that is days on which not less than .01 inch fell, at each station during 1868. It is to be regretted that several of the observers supply no information on this question. From this column it appears that on the average there were in the county 172 or 169 wet days, according as Prince's Town is included or excluded; that the number was greatest at Prince's Town and least at Hele (No. 26), the former being to the latter as $236 : 103 = 100 : 44$; that at the 22 stations whence returns on this point have been received, the number was above the average at 13 or 14, and below it 9 or 8 according as the greater or less average is taken; that the number of wet days is but little affected by the position of the station in relation to Dartmoor or to the sea; that, so far as the evidence goes, stations high above the sea level have a comparatively large number of wet days,—thus Prince's

Town, at 1400 feet, reported 236 wet days, Buckish, at 550 feet, had 213 days, and Tiverton, 300 feet, registered rain on 205 days;—that of the three stations having their gauges at considerable heights above the ground, two only reported their number of wet days, and in each case they were below the average of that of the county; and that some of the returns are scarcely such as might have been anticipated;—thus, few would have expected, probably, that of two stations near Plymouth—Ridgeway and Ham—at nearly the same level above the sea, and having their gauges differing but little in their height above the ground, one would, in the same year, have 51 wet days more than the other; that whilst the annual rainfall of Lupton exceeded that of its neighbour, Torquay, the number of wet days at the former would be lower than that at the latter in the ratio of 171 to 128, or of 100 to 75; or that the five miles which separate Hele from Brampford Speke should not only give the latter five and a half inches more rain than the former in the course of the year, but 80 wet days more also.

The twelfth column shows the number of wet days at each station relatively to the mean number for the entire county.

Mean daily Rate of Rain:—The average daily rainfall on wet days at each station, as well as in the county as a whole, with and without Prince's Town (No. 3), is given in the thirteenth column, and, of course, is the quotient obtained by dividing the total rainfall by the total number of wet days in each case. It appears that, on the average throughout the county, .25 inch fell on each wet day; that the highest rate, .37 inch, occurred at Ham (No. 7) and Lupton (No. 14), and the lowest at Sidmouth, where it was .18 inch, or, in other words, that Ham and Lupton surpassed all the other stations in the comparative greatness of their annual rainfall, or the smallness of their number of wet days, or in the rapidity with which the rain fell, whilst the reverse of all this obtained at Sidmouth; that of the 22 stations which forwarded the data necessary for the calculation of this meteorological element, seven had a daily rate exceeding that of the county as a whole, three had the same rate as the county, and twelve were below it; that the stations having the high rate, were, with the exception of Hele only, beyond what may be called the dry side of Dartmoor; that the height of the station above the sea level did not appear to influence the mean daily rate of rain; and that at neither of

the two stations having their gauges considerably above the ground was the rate below the average.

Mean Annual Rainfall during the three years ending with 1868:—For the third part of Table I. no use has been made of data collected prior to 1866, simply because my former paper began with that year.

In the fourteenth column it is seen that during the three years 1866, 1867, and 1868, the mean annual rainfall in the county was 43·21 inches or 41·85, according as Prince's Town (No. 3) was or was not included; that the former was exceeded at 15 stations, but not reached at 16; that, with the exception of Plymouth (No. 8) and Burton (No. 12), all the comparatively wet stations were beyond the dry side of Dartmoor; that, with the exception of Barnstaple (No. 34) and Northam (No. 35), all the dry stations were within the shelter of this eminence; that all stations more than 450 feet above the sea levels had heavy rainfalls; and that all those having their gauges high above the ground had light ones.

By comparing the means at the foot of the eighth and fourteenth column, it will be found that the county rainfall in 1868, was ·50 inch above, or ·64 inch below the mean annual fall for the three years, according as Prince's Town was or was not included.

The annual fall at each station, as well as in the county, during 1868, relatively to the respective mean annual fall for the three years is shown in the fifteenth column. Thus, for example, the fall at Bovey Tracey (No. 1) in 1868, was to the mean annual fall at the same station, during the three years, as 105:100, or 5 per cent in excess. In the same way it is shown that the county fall in 1868 exceeded the county average by 1 per cent, when Prince's Town was included, but fell 2 per cent below it when it was excluded.

The mean annual fall at each station, relatively to that of the entire county, is shown in the sixteenth and seventeenth columns, the former including, and the latter excluding Prince's Town. Thus at Bovey Tracey the mean annual fall was to that of the entire county as 108:100 in the former case, and in the latter as 111:100; and so on for the other stations.

The ratio of the rainfall at each station in 1868 to the mean annual fall of the county during the three years, is shown in the eighteenth and nineteenth columns, the former with, and the latter without Prince's Town. Thus, at Bovey Tracey (No. 1), the fall in 1868 bore to the mean annual fall

in the county the ratio of 114:100 in the former case, and in the latter of 117:100, or 14 and 17 per cent respectively above the county averages.

Mean Annual number of Wet Days during the three years:

—The mean annual number of wet days during the three years, at each station and in the entire county, with and without Prince's Town, is given in the twentieth column; whence it appears that during the period specified, and taking the county as a whole, every alternate day was on the average a wet one; that the greatest number occurred at Prince's Town (No. 3), and the least at Hele (No. 26), the ratio being as 248:120 = 100:48; that at 11 of the 22 stations from which returns on this question were sent, the number was above the average, and at 10 below it; that the influence of Dartmoor was but little felt as regards the number of wet days; that at all stations 300 feet or more above the sea level the number of wet days exceeded the average; that it was also exceeded at some stations of much lower levels; and that, so far as returns have been received, all stations having their gauges at great heights above the ground had a comparatively small number of wet days.

The twenty-first column shows the relation which the number of wet days at each station in 1868 bore to the average annual number, at the same station, during the three years. Everywhere it was below the average; the nearest approaches to it being at Kingsbridge (No. 13), Lupton (No. 14), and Exeter (No. 24), each of which reached 98 per cent.

The twenty-second column shows the ratio which the number of wet days at each station in 1868, as well as in the county as a whole, bore to the mean annual number in the county during the three years. This, as may be inferred from what has been already stated, was greatest at Prince's Town (No. 3), and least at Hele, being 128 per cent at the former, and 56 at the latter. The average for the county as a whole was 93 per cent, and was surpassed at 13 stations, whilst at 9 it was not reached.

The twenty-third column shows the ratio of the mean annual number of wet days at each station to that of the county as a whole during the three years. As a matter of course Prince's Town took the highest place and Hele the lowest, their per centages being respectively 134 and 65. The county average was exceeded at 11 stations, equalled at one, and not reached at 10.

*Mean daily Rate of Rain during the three years:—*The twenty-fourth column shows that the mean daily rate of rain on wet days during the three years under notice was for the entire county, .23 inch; that this was exceeded at 9 stations, equalled at 2, and not reached at 11; that it was greatest at Prince's Town (No. 3), where it reached .34 inch, and least at Sidmouth (No. 21), Broadhembury (No. 22), Brampford Speke (No. 25), Tiverton (No. 29), and Northam (No. 35), at each of which it was no more than .19 inch; and that there is a tendency in places on the dry side of Dartmoor to have a low daily rain rate, whilst those beyond it have a comparatively high one.

The twenty-fifth column shows the ratio which the mean daily fall at each station, in 1868, bore to that at the same station during the three years. That which the average daily fall during the three years, bore to that of the entire county for the same period, is shown in the twenty-sixth column.

*Recapitulation:—*This part of my paper may be concluded with the following brief recapitulatory summary:—In Devonshire during 1868, the total rainfall of the county was .50 inch, or one per cent, above the average annual fall during the three years ending with 1868. Nine stations also surpassed their annual averages, the excess being in the case of Chagford (No. 2) as much as 16 per cent. At 22 stations the rainfall did not equal the annual average, and at one of them, Teignmouth (No. 18), the defect reached 19 per cent.

The number of wet days was everywhere below the average, the defect amounting to 7 per cent in the county as a whole, and at Ham (No. 7) as much as 15 per cent.

The average daily rate of rain on wet days was in excess in the county as a whole, and, with the exception of three, at each station also.

TABLE II. affords the means for comparing the rainfall of Devonshire with that of England and Wales as a whole, in 1868 and also during the three years ending December 31st, 1868; and, like Table I., is based on data supplied by Mr. Symons's *British Rainfall*.

In the second column the counties are arranged, in descending order, according to their total rainfalls in 1868; Cumberland being the wettest, Devonshire the twelfth, and Essex the driest. The position of each in the series is shown by the numerals in the first column.

SHOWING THE RAINFALL IN 1868, AND THE MEAN ANNUAL FALL DURING 1866, 1867, AND 1868,
IN ENGLAND AND WALES.

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The third column shows that the number of rain gauges in the different counties varies from 106 in Yorkshire to 1 in Rutlandshire. In preparing this column all the gauges were counted from which, in 1868, Mr. Symons recorded the rain-falls. In this way Devonshire is credited with 42 gauges in Table II., though with no more than 31 in Table I., it being thought desirable to omit in the latter those which had been brought into operation since 1867; and where several existed in the same town to select one of them. At Exeter, for example, there are four gauges. To introduce the whole of them would be to import a probable error in the averages, hence the returns from the long-established gauge at the Devon and Exeter Institution was alone made use of in Table I. Local knowledge would enable any one to make a fair selection, so long as he confined himself to his own county, but it would be eminently improbable that he could do this when the area was extended to the entire kingdom; and as it appeared that cases similar to that just mentioned occurred in almost every county, it seemed to be the fairest, as well as the only practicable method to incorporate all the returns which Mr. Symons had accepted. It may be hoped that such errors as are thus introduced may go far to neutralize one another, and that they may leave the ratios unaffected.

The average number of acres in each county represented by every gauge in 1868, is shown in the fourth column, and was obtained, of course, by dividing the total average of the county by the number of gauges it contains. It appears that this number is least in the case of Middlesex, where there is one gauge for every 7,466 acres; that it is greatest in that of Radnorshire, where every gauge represents 153,993 acres, or upwards of 20 times the Middlesex mean; that in the entire kingdom as a whole, there is one gauge for every 37,029 acres; that in 32 counties this acreage is exceeded; that the counties of Cumberland, Westmoreland and Carnarvon are amongst the 20 in which this average area is not reached; and that 21 counties surpass Devonshire in the relative number of its rain-gauges.

That Middlesex should be thickly studded with stations at which the rainfall is observed is by no means surprising; but it is eminently creditable to the meteorologists of the three mountainous and thinly peopled districts that have just been named, that for every 14 gauges in the kingdom generally, there should, on an equal area, be 21 in Carnarvonshire, 24 in Cumberland, and upwards of 28 in Westmoreland. It

should be remarked, too, that in Cumberland there are 11 gauges upwards of 1,000 feet above the sea, 3 above 2,000 feet, and one as much as 3,200 feet; that in Westmoreland there are 5 at an elevation exceeding 1000 feet; and that, though only one of the Carnarvonshire series attains this altitude, the returns made from every gauge in the county are in every respect complete—they contain full information as to height above the sea level and above the ground, the total rainfall, and the number of wet days. It may also be remarked that of the 14 gauges in this model county, 11 are superintended by Major Mathew, who also has gauges in Merionethshire and in Anglesea.

The fifth column shows the average height of the gauges in each county and in the entire kingdom as a whole. The latter amounts to 3 feet, and is exceeded in 24 counties, but not reached in 28. The maximum, reaching 8 feet 1 inch, occurs in Middlesex, where, no doubt, several of the gauges are placed on the roofs of houses. The minimum is as high as 14 inches, and is that of Brecknock and Buckingham shires. The Devonshire mean is 5 feet 7 inches, and is only surpassed by those of Middlesex, and Gloucester, Bedford and Cambridge shires.

In the sixth column is given the average height of the stations above the sea level in every county and the entire country. It ranges from 1047 feet in Montgomeryshire to 44 in Cambridgeshire, and averages 292 feet for England and Wales as a whole, with the exception of Rutlandshire, whence no return on this head has been sent in. In 27 counties the general average is not reached, and in the remaining 24 it is surpassed. The Devonshire mean height is 285 feet, or 7 feet below that for the entire country.

The seventh column shows for 1868 the average annual rainfall in each county, as well as the general average for Britain south of the Tweed and Solway. The greatest was that of Cumberland, where it reached 72·84 inches; the least was that of Essex, and was no more than 19·80 inches; Devonshire averaged 43·74 inches, and the entire Kingdom, 34·44. The Cumberland, the Devonshire, the general, and the Essex averages were respectively as the numbers 211, 127, 100 and 57.

The eighth column contains the average number of wet

days for each county and for the entire country. The general average amounted to 156 days; the greatest, that of Merionethshire, to 203 days,—the only instance in which 200 days were reached; the Devonshire to 173 days; and the least, or Rutland, to 122 days. There were 29 counties below, and 23 above the general average. Taking the entire country as a whole, there were in every seven days of the year, three wet and four dry ones.

In the ninth column are given the county and general average rates of daily rainfall on wet days during 1868. The general, the greatest or Cumberland, the Devonshire, and the least or Suffolk averages were .22, .38, .25 and .14 inch respectively. Sussex alone equalled the general mean. Of the remaining counties 36 were below, and 15 above this daily rate.

The tenth, eleventh and twelfth columns show the average annual rainfall, number of wet days, and daily rate of rain on wet days during the three years ending December 31st, 1868. On the whole, 1868 fell below the average of the three years in the rainfall and number of wet days, but rose above it in the mean daily rate of rain on wet days.

The average rainfall in 1868 was, in the entire country, 34.44 inches, against an annual average of 35.64; that is a defect of .90 inch, or 2.5 per cent.; the number of wet days was 156 against 171, or a defect of 15 days, that is of 9 per cent.; and the mean daily rain rate was .22 inch against .21, that is an increase of .01 inch, or 5 per cent.

On comparing the seventh and tenth columns, it will be seen that in some counties the mean rainfall in 1868 was above, and in others below the annual average during the three years. Thus in Cumberland it was 72.84 inches in 1868, against an average of 68.77 inches; whilst in Glamorganshire the 1868 fall was 44.80 inches, and the average 45.24. An inspection of the two columns shows that 14 counties belong to the former, and 38 to the latter class; in other words, that the fall in the former was in 1868 above, and in the latter below the average for the three years.

The eighth and eleventh columns show that in every county the number of wet days was in 1868 below the average, except in Denbighshire, where it was above. The great meteorological peculiarity of 1868 was the paucity of wet days, regard being had to the amount of rain which fell.

The order in which the counties stand when arranged, as a descending series, according to their average annual rainfall for the three years, is indicated by the numerals in the last column. Those numbered from 1 to 18 inclusive, that is, about one third of the whole, had average falls above that of the entire country, and may therefore be called the wet counties. It may be remarked in passing, that in my paper last year there were 19 "wet" counties, and that 17 of them are included in the wet list for the present year. Returning to the latter, it will be seen that they form two classes:—First, those that are on the western seaboard of England and Wales; and, second, those that are more or less in the interior, but are of great general elevation.

In following those forming the first class, we pass, from Cumberland, along the shores of the Irish Sea, St. George's Channel, the Bristol Channel, and the English Channel as far east as Dorsetshire inclusive; and in doing so, every county we visit is a wet one, with the exception of Cheshire, Flint, Denbigh, Gloucester, and Somerset shires. Now the excepted counties either have not a south-westerly aspect, or they fail to attain to any considerable elevation above the sea level, or they lie on the dry side of Ireland, or of some high land which has wrung the moisture out of the atmosphere in its passage from the south-west. Thus, Cornwall, Devon, Dorset, and the Welsh maritime counties from Glamorgan to Anglesea, are wet from their aspect and exposure, and in some of them the rainfall is enhanced by their great height. Somerset and Gloucester shires are dry from their aspect, and from being on the dry side of Cornwall and Devonshire. Denbigh, Flint, and Cheshire are dry from their aspect, and from being on the dry side of Carnarvonshire and Ireland. Lancashire, Westmoreland and Cumberland, though similarly protected by Ireland, are wet through their great elevation; and this is strikingly supported by the fact that the rainfall is greatest in Cumberland, the highest, and least in Lancashire, the lowest of the three. The rainfall of Monmouthshire is probably greater than that which might have been assigned to it *a priori*. It is not easy to see why, during the last three years, its average annual rainfall has exceeded that of Devonshire by 4·7 per cent. It is true that on the average its gauges are 111 feet higher above the sea level, and 4·25 feet near the ground—conditions favourable for a heavier rainfall,—but it is by no means so much exposed to the direct action of the wet, or south-westerly winds.

Of the five "South-westerly" counties of England,—Cornwall, Devon, Dorset, Somerset, and Wilt shires—the order in which they stand when arranged, as a descending series, according to their average annual rainfalls and daily rates of rain during the three years, is that in which their names have just been given; this is also their order so far as the first two are concerned, in the matter of wet days, but the remaining three must be reversed so that the list may close with Dorsetshire.

Recapitulation :—The following brief summary, defining the meteorological position of Devonshire amongst the counties of England and Wales, may appropriately close this paper :—22 counties have a greater relative number of stations at which the rainfall is registered; 47 have their gauges nearer the ground, and in 26 the stations are at less heights above the sea level. In 1868, its rainfall was 27 per cent. above the average of the entire country, 40 per cent. below that of the wettest county, 121 per cent. above that of the driest; and there were 11 counties in which the rainfall was greater. Its number of wet days was 11 per cent. above that of the average of England and Wales as a whole, 15 per cent. below that of Merionethshire, where the number was greatest, 42 per cent. above that of Rutland where it was least, and there were 11 counties in which the number was greater. Its mean daily rate of rain on wet days was 13 per cent. above that of the entire kingdom, 34 per cent. below that of Cumberland where the maximum was reached, 79 per cent. above that of Suffolk or the minimum, and there were 10 counties in which the rate was greater.

During the three years ending with 1868, its average annual rainfall was 24 per cent. above the average of the entire country, 36 per cent. below that of the wettest county, 95 per cent. above that of the driest, and there were 11 counties in which the average annual was greater—the same eleven as exceeded it in 1868. Its average yearly number of wet days was 9 per cent. above that of England and Wales as a whole, 13·5 per cent. below that of Merionethshire where the number was greatest, 37·5 above that of Rutland where it was least, and there were 11 counties in which the number was greater—the same which surpassed it in this respect in 1868. Its mean daily rate of rain on wet days was 19 per cent. above that of the entire kingdom, 28·5 per cent. below that of Cumberland, where the maximum was reached, 78·5 per cent. above that of Cambridge, or the minimum, and there were 7 counties in which the rate was greater.

ON THE APPLICATION OF WEIGHT TO TEST THE FIGURE OF THE EARTH.

BY JAMES JERWOOD, M.A., F.G.S., F.Q.P.S.,

Recorder of South Molton, &c.

THOMSON and Tait, in their *Treatise of Natural Philosophy*, p. 646, tell us that "during the last seven years geodetic work of extreme importance has been in progress, through the co-operation of the governments of Prussia, Russia, Belgium, France, and England, in connecting the triangulation of France, Belgium, Russia, and Prussia, which were sufficiently advanced for the purpose in 1860, with the principal triangulation of Great Britain and Ireland, which had been finished in 1851." With reference to this work Sir Henry James makes the following remarks: "Before the connexion of the triangulation of the several countries into one great network of triangles, extending across the entire breadth of Europe, and before the discovery of the electric telegraph and its extension from Valentia (Ireland) to the Ural Mountains, it was not possible to execute so vast an undertaking as that which is now in progress. It is, in fact, a work which could not possibly have been executed at an earlier period in the history of the world. The exact determination of the figure and dimensions of the earth has been one great aim of astronomers for upwards of two thousand years; and it is fortunate that we live in a time when men are so enlightened as to combine their labours to effect an object that is desired by all, and at the first moment when it was possible to execute it."

This extract clearly sets forth the long period and the scientific labours which it required to determine the figure of the earth. Our object, however, is to apply one peculiar test to that figure; namely, WEIGHT; and to effect that object we consider it necessary to cite certain propositions generally admitted to be true.

Newton, by supposing that the earth was originally a

homogeneous mass, revolving on an axis in 23h. 56min. 4sec. solar time, came to the conclusion that it assumes the figure of an oblate spheroid, of which the polar is to the equatorial diameter as 229 : 230.*

It was subsequently demonstrated by Clairault,† that if a fluid mass revolving on an axis be not homogeneous but be composed of strata which increase in density towards the centre, its figure of equilibrium will still be an elliptic spheroid, but that its oblateness will be less than if it were homogeneous.

Clairault's investigations moreover determine the form of equilibrium which a fluid assumes under the following suppositions; viz. (1), that the fluid is homogeneous, with a spheroidal nucleus of different density; (2), that the whole mass is fluid and heterogeneous.

The form which makes equilibrium possible in all the variety of cases which these suppositions include is approximately an elliptic spheroid. The ellipticity or oblateness of the spheroid is different according to the law of density, &c., but in all cases the following theorems are true:—

1st. The increase of *degrees* and of *gravity* on going from the equator to the poles is as the square of the sine of the latitude.

2nd. The sum of the ellipticity and of the ratio of the whole increase of gravity to the equatorial gravity is the fraction $\frac{1}{4}$ multiplied into the ratio of the centrifugal force at the equator to the force of gravity.‡

These celebrated theorems admit of varied proof by actual admeasurement. Accordingly geodetic measures and pendulum experiments have been undertaken and completed in various parts of the globe by the ablest astronomers, furnished with the best instruments. A condensed epitome of their labours is given in Airy's treatise already referred to. The lengths of meridian arcs corresponding to a given difference of latitude have been determined in various places by geodetic measurements, and the law of the variation of gravity at different points of the earth's surface has been ascertained by the vibrations of pendulums. The results of these admeasurements and experiments have not only been applied to test Clairault's theorem, but also to determine the earth's ellipticity. Other deductions respecting the figure of the earth have been derived from assumptions more or less accurate according to

* Principia, lib. 3, prop. 19. † Fig. de la Terre.

‡ Airy, "Fig. of the Earth," Metrop., p. 170.

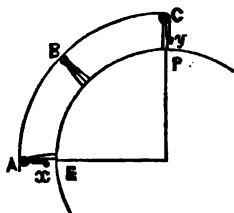
the hypothesis adopted with regard to the earth's density, &c., but geodetic measures and the vibrations of pendulums in almost every latitude have clearly established the fact, that the force of gravity varies in accordance with Clairault's theorem.

Since then the intensity of gravity on going from the equator to the pole varies as the square of the sine of latitude, it follows that the *weight* of a body on being carried from the equator to the poles varies in the same rate. Hence another criterion by which the figure of the earth may be tested is furnished; for if a body vary in weight at all the intermediate latitudes between the equator and the poles, according to Clairault's law, such variation would undoubtedly go far to establish the results derived from theory and to confirm the inferences from experiments.

But how can the weight of a body at different stations be ascertained so as to determine such a fact if it exist? Sir John Herschel* has answered this question so clearly and satisfactorily that I think I cannot do better than transcribe his observations on the point.

"When we *weigh* a body by a balance or steelyard, we do but counteract its weight by the equal weight of any body under the circumstances; but if both the body weighed and its counterpart be removed to another station, their gravity, if changed at all, will be changed equally, so that they will still continue to counterbalance each other. A difference in the intensity of gravity could therefore never be detected by these means; nor is it in this sense that a body weighing 194 pounds at the equator will weigh 195 pounds at the pole. If counterbalanced in a scale or steelyard at the former station, an additional pound placed in one or the other at the latter would inevitably sink the beam.

"The meaning of the proposition may be thus explained. Conceive a weight suspended at the equator by a string without weight passing over a pulley A, and conducted (supposing such a thing possible) over other pulleys (B) round the earth's convexity till the other end hung down at the pole, and there sustained the weight *y*. If then the weights *x* and *y* were such, as at one station, equatorial or polar, would exactly counterpoise each other on a balance, or when suspended side

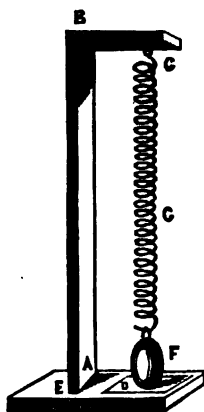


* Astronomy, page 123.

by side over a single pulley, they would not counterbalance each other in this supposed situation, but the polar weight y would preponderate, and to restore the equipoise the weight x must be increased by $\frac{1}{11}$ th part of its quantity."

The following ingenious mode of ascertaining the variation in weight is extracted from the same work :—

"The means by which this variation of gravity may be shown to exist, and its amount measured, are twofold (like all estimations of mechanical power, statical and dynamical). The former consists in putting the gravity of a weight in equilibrium, not with that of another weight, but with a natural power of a different kind, not both to be affected by local situation. Such a power is the elastic force of a spring. Let A B C be a strong support of brass standing on the foot A E D, cast in one piece with it, into which is let a smooth plate of agate (D), which can be adjusted to perfect horizontality by a level. At C let a spiral spring (G) be attached, which carries at its lower end a weight F, polished and convex below. The length and strength of the spring must be so adjusted that the weight F shall be sustained by it just to swing clear of contact with the agate plate on the highest latitude at which it is intended to use the instrument. Then if small weights be added cautiously, it may be made to descend till it *just grazes* the agate, a contact which may be made with the utmost imaginable delicacy. Let these weights be noted—the spring G carefully lifted off its hook and secured for travelling from rust, strain, or disturbance, and the whole apparatus conveyed to a station on a lower latitude. It will then be found on remounting it that, although loaded with some additional weights as before, the weight F will no longer have power enough to stretch the string to the extent required for producing a similar contact. More weights will require to be added, and the additional quantity necessary will it is evident measure the difference of gravity between the two stations as exerted on the whole quantity of pendent matter, *i. e.*, the sum of the weight F, and *half* that of the spiral spring itself. Granting that a spiral spring can be constructed of such strength and dimensions that a weight of 10,000 grains, including its own, shall produce an elongation of ten inches without permanently straining it, one additional grain will produce a further ex-



tension of $\frac{1}{1000}$ th of an inch,—a quantity which cannot possibly be mistaken in such a contact as that in question. Thus we should be provided with the means of measuring the power of gravity on any station to within $\frac{1}{1000}$ th of the whole quantity."

(The other mode of measuring dynamically the variation of gravity referred to is by the oscillation of pendulums.)

Not differing widely perhaps in principle from the foregoing contrivance, or the weighing-machines in common use by Salter and others, the body to be weighed is attached to the end of a spiral spring connected with an index, which points out the weight on a dial-plate. Machines of this description are said to be capable of weighing considerable quantities of matter, and of indicating the true weights to a great degree of exactness. They are commonly used at railway stations. An instrument of this kind is described in *Young's Lectures*.* Although a machine of this sort could not perhaps be constructed to act with so great nicety as that devised by Sir J. Herschel, still it is likely that one might easily be made to show roughly whether the weight of a body does vary on being carried from one latitude to another. I am persuaded that such a machine, constructed with only moderate accuracy, would sufficiently indicate such variation in weight as to confirm the deduction of theory. At all events, the experiment could easily be made without much trouble or expense, and it is by way of inducing parties having the opportunity of carrying the suggestion into operation to make the trial that I have drawn up this paper. A ship that leaves the port of London for a place in a distant latitude, either north or south, at once affords an arena for testing the project. The inquiry is so interesting to men of science that one might hope a trial will be made without delay, either by the commanders of Government vessels or by others. Whether the experiment were made by the instrument described by Sir John Herschel or by the more common and less accurate one to which I have referred, I think it might be serviceable to have the means at hand in any latitude of readily ascertaining the variation in weight which theory points out. I have endeavoured to furnish such aid by constructing the following table, which I wish now to explain.

Let m be the ratio of the centrifugal force to gravity at the equator = $\frac{1}{289}$, † e the earth's ellipticity, G the gravitation at the equator, g the gravitation at a place the latitude of which

* See Kelland's edition, p. 98.

† Airy's *Traité* ut supra, or O'Brien's *Traité*, p. 48.

is λ ; then supposing the earth to have been a homogeneous fluid according to Newton's hypothesis, we have

$$g = G (1 + \epsilon \sin^2 \lambda).$$

But supposing the matter of the earth heterogeneous, and increasing in density from the surface to the centre, we have, by Clairault's theorem,

$$\left. \begin{aligned} g &= G (1 + \frac{5m}{2} - \epsilon \sin^2 \lambda) \\ &= G (1 + n \sin^2 \lambda) \end{aligned} \right\} \text{Putting } \frac{5m}{2} - \epsilon = n.$$

Again, let g' be the gravitation at a place of which the latitude is λ' , then

$$g' = G (1 + \epsilon \sin^2 \lambda');$$

$$\text{Hence, } \frac{g'}{g} = \left\{ \begin{array}{l} \frac{1 + \epsilon \sin^2 \lambda'}{1 + \epsilon \sin^2 \lambda} \\ \text{or, } \frac{1 + n \sin^2 \lambda'}{1 + n \sin^2 \lambda} \end{array} \right\} \text{ according to the hypothesis adopted.}$$

It follows from what has been done, that if W denote the weight of a body at a place the latitude of which is λ , and W' the weight of the same body at a place of which the latitude is λ' , then

$$\frac{W'}{W} = \left\{ \begin{array}{l} \frac{1 + \epsilon \sin^2 \lambda'}{1 + \epsilon \sin^2 \lambda} \\ \text{or, } \frac{1 + n \sin^2 \lambda'}{1 + n \sin^2 \lambda} \end{array} \right\} \text{ as the case may be;}$$

$$\text{and } \therefore W' = \frac{1 + \epsilon \sin^2 \lambda'}{1 + \epsilon \sin^2 \lambda} \times W;$$

$$\text{or, } \frac{1 + n \sin^2 \lambda'}{1 + n \sin^2 \lambda} \times W.$$

Now if a known latitude be taken for λ , and each degree of latitude from the equator to the poles be taken for λ' , the above expressions

$$\frac{1 + \epsilon \sin^2 \lambda'}{1 + \epsilon \sin^2 \lambda} \quad \text{or} \quad \frac{1 + n \sin^2 \lambda'}{1 + n \sin^2 \lambda}$$

can be converted into a number, which, being multiplied by W , the weight of the body at the place of which the latitude is λ , will give the weight of the same body at any other place the latitude of which is λ' .

The multipliers deduced from the above expressions will vary according to the earth's oblateness, the measure of which has been obtained by many authors from various principles. The following table exhibits some of their results:—

AUTHORS.	ELLIPTICITIES.	PRINCIPLES.
Newton	$\left(\frac{1}{230}\right)$	Theory of Gravity.
Clairault	$\left(\frac{1}{1155}\right)$	Rotary Motion.
	$\left(\frac{1}{313}\right)$	Vibration of Pendulums.
Manpertuis	$\left(\frac{1}{314}\right)$	Mensuration of Arcs.
	$\left(\frac{1}{313}\right)$	
Horsley	$\frac{1}{308}$	The mean of six Measurements.
Boscovich	$\frac{1}{318}$	Measurement of Arcs.
Trieswicker	$\frac{1}{318}$	Occultation of Stars.
Laplace	$\left(\frac{1}{314}\right)$	Precession and Nutation.
	$\left(\frac{1}{308}\right)$	Theory of the Moon.

Lalande makes it $\frac{1}{317}$; Sajour, $\frac{1}{307}$; Carouge, $\frac{1}{308}$; Playfair, $\frac{1}{304}$; Hutton thinks it $\frac{1}{310}$; Delambre makes it $\frac{1}{308}$; Ponteconlant makes it $\frac{1}{310}$; lastly, Sir Henry James, *ut supra*, Tait, and Thomson, $\frac{1}{308}$.

Airy says that although Newton's mode of deducing the ellipticity is defective it is not erroneous. Mr. Dalby, in the *Philosophical Transactions* for 1791, has inferred that the degrees of the meridian measured in middle latitudes correspond to an ellipsoid, the axes of which are in the ratio assigned by Newton. Admitting that the earth was originally a homogeneous fluid, Newton's ellipticity is nearly correct. Hence Dalby's inference seems to indicate that the middle latitudes correspond to such an hypothesis, and that they are not affected by the matter which has been drawn from the poles and accumulated at the equator by the earth's revolution. Be this, however, as it may, the first column of multipliers in the following table has been calculated on the supposition that $\epsilon = \frac{1}{310}$; that is, λ has been taken for $51^\circ 32'$, the latitude of London, which makes the expression

$$\frac{230 + \sin^2 \lambda'}{230 + \sin^2 \lambda} = \frac{230 + \sin^2 \lambda'}{230.61304}.$$

The taking λ' from 1° to 90° has furnished the first column of multipliers in the table.

Laplace (*Mec. Cel.* liv. 3, v. 842) makes the earth's oblateness $\frac{1}{331.78}$, which he says agrees in a remarkable manner with the ellipticity deduced from the measures in France and

at the equator. His celebrated commentator, Dr. Bowditch, however, has shown that Laplace has made a mistake in the matter, which being corrected the ellipticity becomes $\frac{1}{317}$. (Translation, *Mec. Cel.*, vol. ii. p. 485.) Dr. Bowditch comes to the conclusion that the earth's oblateness does not differ much from $\frac{1}{300}$, a value which he says he has always used in his calculations. This value agrees nearly with $\frac{1}{305}$, the ellipticity adopted by Sir John Herschel.* English writers on the figure of the earth† with whose works I am acquainted agree in assigning $\frac{1}{307}$ as the ellipticity of the earth obtained from geodetic measures.

From an irregularity which depends upon the longitude of the moon's node, Laplace made the earth's ellipticity $\frac{1}{307}$; from the irregularity depending upon the motion in longitude he made it $\frac{1}{304}$. Playfair (as above) makes it $\frac{1}{304}$, Sajour $\frac{1}{307}$. All these values differ but little from each other. I, therefore, assume that ϵ may fairly be taken = $\frac{1}{305}$. Hence, in Clairault's theorem, $\frac{e^2}{2} - \epsilon = n$, we find $n = \frac{1}{308}$, and the second column of multipliers in the table has been deduced from the expression

$$\frac{186 + \sin^2 \lambda}{18661304},$$

in the manner already explained. The third column of multipliers in the table has been calculated from the expression,

$$\frac{194 + \sin^2 \lambda}{19461304}.$$

If the trial above recommended be made, and the weight of the body be taken at London, the table will readily assist to indicate the *theoretical* variation in weight in any latitude. If the weight at London be multiplied by the proper multiplier in the first column, the result will show the variation on the hypothesis that the earth is homogeneous. If the known weight be multiplied by the multiplier in the second column, the product will indicate the variation corresponding to the oblateness as derived from geodetic measures, and nearly agreeing with that obtained from various other sources.

If the weight of the body at London be multiplied by the proper number in the third column, the result will show the variation which corresponds to the ellipticity derived from a great number of pendulum experiments.

* Astronomy.

† Airy's Tracts, p. 189; Pratt's Mec. Phil. p. 613; O'Brien's Tracts, p. 47.

It would be desirable to use *each* multiplier, and to tabulate the results with the weights shown by the instruments. A table so formed would at sight indicate the experimental variation, and also show how nearly it agrees with, or how much it differs from, the theoretical variation obtained by the multipliers.

My object being merely to trace some experiments tried in the rough, nothing has been said respecting the corrections for elevation or levels, nor yet with regard to the effect which different temperatures may have on the spring of the instrument employed.* These points may be deferred for the present. In using the table the number answering to the nearest degree will perhaps point out the variation sufficiently near for practical purposes.

It has been remarked above, that if the weight of a body in the place of which the latitude is λ be multiplied by either of the *decimal* multipliers opposite to the degree corresponding to the latitude λ' in the table, the product will give the weight of the same body at the place λ' . It may not be inexpedient to add two or three examples. Suppose, as Sir John Herschel has done, that the body at London (latitude λ) weighs 10,000 grains,

$$\text{At the equator it weighs } \left\{ \begin{array}{l} .9973416 \\ .9967149 \\ .9968499 \end{array} \right\} \times 10,000 = \left\{ \begin{array}{l} 9973 \\ 9967 \\ 9968 \end{array} \right\} \text{ grains.}$$

Omitting fractions according as the first, second, or third column of multipliers is used; so that it would require 27 grains in the first instance, 33 in the second, and 32 in the third *to be added* in order to produce the contact in Sir John Herschel's instrument, or that the index may point to the same figure as it did in London in the other case.

Take Madras, latitude $13^{\circ} 4'$; the multiplier in the third column is .9971103, which, multiplied by 10,000, gives 9971, so that 32 grains must be *added* to restore the equilibrium. At Spitzbergen, latitude 80° , the corresponding multiplier is 1.0018333, which, multiplied by 10,000, gives 10,018, so that 18 grains must be *deducted* from the weight in London to produce the equilibrium.

The variation in weight becomes the more remarkable when larger quantities are taken. For instance, take a ship's cargo that weighs a 1000 tons at London, using the multiplier in

* Dr. Young (Lectures: Kelland's edition, p. 96) says: "The strength of all springs is somewhat diminished by *heat*; and for each degree of Fahrenheit that the temperature is raised we must deduct about one part in 5000 for the opponent weight indicated by the spring in the steelyard."

the first column in the table; it will be found that it weighs 2 tons 13 cwt. 0 qrs. 19 lbs. less at the equator; employing the third tabular multiplier the loss is 3 tons 3 cwt. 0 qrs. 1 lb.; Similarly at Jamaica, latitude 18° , the loss is 2 tons. 4 cwt. 3 qrs. 16 lbs., or 2 tons 13 cwt. 0 qrs. 21 lbs., the same multipliers being used.

At Spitzbergen, latitude 80° , the *gain* is 1 ton 10 cwt. 3 qrs. 21 lbs., or 1 ton 17 cwt. 1 qr., employing the same multipliers.

Besides the immediate objects for which the multipliers in the table have been formed, some of them possibly may be serviceable in other matters. Thus, if the length of the seconds' pendulum at London be multiplied by the multiplier in the third column corresponding to any latitude, the product will give the theoretical or calculated length of the seconds' pendulum for that latitude.

The length of the seconds' pendulum at London being taken = $39.13948'$, and multiplied by $.9968499$, the third tabular multiplier for the equator gives 39.0161867 for the length of the seconds' pendulum at the equator.

In Airy's Table, Pulo Gann. Long. $0^\circ 2' N.$, or Rawak; $0^\circ 2' S.$, the calculated length of the seconds' pendulum is 39.01677 . The observed length at the latter place is 39.01433 , the observed length at the former 39.02126 . Why the observed length of these pendulums at the same distance from the equator differ so much is an interesting question not easily answered. At Spitzbergen, lat. $79^\circ 50'$, the observed length is 39.21469 , the calculated length is 39.21089 . If $39.13948 \times 1.0018333$ (the multiplier corresponding to 80°) gives 39.2112343 , the length of the seconds' pendulum at the second degree, $39.13948 \times .9971103$ (the multiplier for 13°) = 32.0263669 , the length of the seconds' pendulum in that latitude.

In Airy's Table the calculated length for Madras, latitude $13^\circ 4'$, is 39.02700 ; the observed length, 39.02630 . The calculated length at Bahai, $12^\circ 59'$ by the same Table, is 39.02688 ; the observed length, 39.02433 .

Once more, $39.1394 \times .9973406$ (the tabular multiplier of 18°) gives 39.0301229 for the length of the seconds' pendulum in that latitude. By the Table already named the calculated length at Jamaica, lat. $17^\circ 56'$, is 39.03576 ; the observed length, 39.03503 . The minute discrepancies between some of these works are explained by the small differences in latitudes.

* Treatise, page 230.

Barlow, in his *Mathematical Dictionary*, Art. Earth, says the weight of a body at the equator is to the weight of the same body at the poles as 1 : 1.100569. This assumes that $n = \frac{1}{178}$ and $e = \frac{1}{317}$. Whatever may be said respecting the probability of the correctness of this assumption, or of any of the others which have been named, I am not aware that any attempt has been made to determine whether they are correct or not by actual experiment.

With regard to the modes of testing which have been discussed, Sir John Herschel says, speaking of the contrivance already cited, "Whether the process above described could ever be so far perfected and refined as to become a substitute for the use of the pendulum, must depend on the degree of pursuance and uniformity of action of springs, on the constancy or variability of the effect of temperature on their elastic forces, on the possibility of transporting them absolutely unaltered from place to place, &c. The great advantage, however, which such an apparatus and mode of observation would possess in point of convenience, cheapness, portability, and expedition, over the present laborious, tedious, and expensive process, render the attempt well worth making."

The figure of the earth still forms an interesting problem in physical astronomy: nor is it less desirable to ascertain how nearly the results of theory agree with the real state of things. The actual comparison of the weight of a body in different latitudes would appear to afford an additional test on each of these points. My object has been simply to call the attention of competent parties to the subject, and to attempt to facilitate their labours should they be induced to undertake the task.

THE TABLE.

Lat. of λ' in Degrees.	$\sin \lambda'$	$\sin^2 \lambda'$	Decimal Multipliers from		
			$230 + \sin^2 \lambda'$	$186 + \sin^2 \lambda'$	$194 + \sin^2 \lambda'$
			23061304	18661304	19461304
Equator	—	—	.9973416	.9967149	.9968499
1 deg.	.017450	.0003045	.9973430	.9967165	.9968515
2	.034899	.0012181	.9973474	.9967214	.9968562
3	.052336	.0027391	.9973535	.9967296	.9968640
4	.069756	.0048659	.9973627	.9967409	.9968749
5	.087150	.0075951	.9973746	.9967556	.9968889
6	.104520	.0109245	.9973890	.9967734	.9969068
7	.121869	.0148621	.9974060	.9967945	.9969262
8	.139170	.0193683	.9974256	.9968187	.9969494
9	.156430	.0244704	.9974480	.9968460	.9969756
10	.173640	.0301609	.9974724	.9968764	.9970048
11	.190810	.0364084	.9974995	.9969100	.9970303
12	.207910	.0432266	.9975291	.9969465	.9970720
13	.22495	.0506026	.9975611	.9969860	.9971103
14	.24192	.0585253	.9975954	.9970285	.9971506
15	.25881	.0669827	.9976321	.9970738	.9971941
16	.27563	.0759719	.9976711	.9971202	.9972346
17	.29237	.0854804	.9977123	.9971729	.9972886
18	.30901	.0954872	.9977557	.9972266	.9973406
19	.32556	.1059894	.9978012	.9972828	.9973945
20	.34202	.1169777	.9978489	.9973417	.9974510
21	.35836	.1284619	.9978986	.9974033	.9975100
22	.37459	.1403252	.9979501	.9974668	.9975710
23	.39073	.1526699	.9980037	.9975330	.9976344
24	.40673	.1654293	.9980590	.9976016	.9977000
25	.42261	.1786993	.9981161	.9976797	.9977676
26	.43837	.1921683	.9981749	.9977446	.9978374
27	.45399	.2061069	.9982354	.9978193	.9979090
28	.46947	.2204021	.9982974	.9978959	.9979824
29	.48480	.2350311	.9983608	.9979743	.9980576
30	.50000	.2500000	.9984257	.9980545	.9981448
31	.51503	.2652559	.9984919	.9981363	.9982128
32	.52991	.2808047	.9985593	.9982232	.9982928
33	.54463	.2966219	.9986279	.9983044	.9983741
34	.55919	.3126935	.9986975	.9983905	.9984566
35	.57357	.3289826	.9987682	.9984778	.9985404
36	.58778	.3454854	.9988398	.9985662	.9986252
37	.60181	.3621753	.9989121	.9986557	.9987109
38	.61566	.3790373	.9989853	.9987460	.9987970
39	.62932	.3960437	.9990590	.9988371	.9988848
40	.64278	.4131662	.9991332	.9989289	.9989729
41	.65605	.4304017	.9992080	.9990213	.9990615
42	.66913	.4477349	.9992831	.9991143	.9991505
43	.68199	.4651104	.9993585	.9992067	.9992398
44	.69465	.4825387	.9994341	.9993006	.9993294
45	.70710	.4999905	.9995097	.9993942	.9994191

Lat. λ' in Degrees.	Sin λ'	Sin ² λ'	Decimal Multipliers from		
			230 + sin ² λ'	186 + sin ² λ'	194 + sin ² λ'
			23061304	18661304	19461304
46	·71933	·5174357	·9995854	·9994876	·9995087
47	·73136	·5348729	·9996176	·9995811	·9995983
48	·74314	·5522571	·9997364	·9996742	·9996876
49	·75470	·5695721	·9998114	·9997665	·9997766
50	·76604	·5868173	·9998862	·9998594	·9998652
51	·77714	·6039466	·9999605	·9999512	·9999527
52	·78801	·6209597	1·0000343	1·0000424	1·0000407
53	·79863	·6378099	1·0001074	1·0001327	1·0001272
54	·80901	·6544972	1·0001797	1·0002221	1·0002131
55	·81915	·6711068	1·0002509	1·0003106	1·0002927
56	·82903	·6872908	1·0003211	1·0003978	1·0003815
57	·83867	·7033374	1·0003915	1·0004838	1·0004639
58	·84905	·7191888	1·0004607	1·0005688	1·0005454
59	·85718	·7347233	1·0005276	1·0006574	1·0006252
60	·86602	·7499907	1·0005938	1·0007333	1·0007037
61	·87461	·7649427	1·0006586	1·0008139	1·0007850
62	·88294	·7795831	1·0007221	1·0008924	1·0008557
63	·89100	·7938811	1·0007841	1·0009690	1·0009251
64	·89879	·8078235	1·0008446	1·0010433	1·0010003
65	·90630	·8213797	1·0009034	1·0011164	1·0010705
66	·91354	·8345554	1·0009605	1·0011870	1·0011382
67	·92050	·8473203	1·0010159	1·0012554	1·0012038
68	·92718	·8596628	1·0010694	1·0013215	1·0012672
69	·93358	·8715717	1·0011211	1·0013853	1·0013284
70	·93969	·8830174	1·0011706	1·0014467	1·0013872
71	·94551	·8939892	1·0012183	1·0015055	1·0014436
72	·95105	·9044962	1·0012638	1·0015618	1·0014976
73	·95630	·9145097	1·0013072	1·0016154	1·0015490
74	·96126	·9240208	1·0013480	1·0016664	1·0015979
75	·96592	·9330015	1·0013874	1·0017145	1·0016440
76	·97029	·9414627	1·0014241	1·0017599	1·0016875
77	·97437	·9493969	1·0014585	1·0018024	1·0017278
78	·97814	·9567579	1·0014904	1·0018418	1·0017661
79	·98162	·9635779	1·0015201	1·0018784	1·0018012
80	·98480	·9698311	1·0015447	1·0019119	1·0018333
81	·98768	·9755118	1·0015717	1·0019423	1·0018625
82	·99026	·9806149	1·0015939	1·0019697	1·0018887
83	·99254	·9851357	1·0016161	1·0019939	1·0019119
84	·99452	·9890701	1·0016356	1·0020150	1·0019321
85	·99619	·9923946	1·0016449	1·0020328	1·0019492
86	·99756	·9951259	1·0016564	1·0020474	1·0019633
87	·99862	·9972419	1·0016660	1·0020588	1·0019741
88	·99939	·9987804	1·0016726	1·0020671	1·0019820
89	·99984	·9996801	1·0016765	1·0020718	1·0019867

ON SCIENCE AND ART AS A BRANCH OF NATIONAL EDUCATION.

BY R. VIVIAN, M.A.

(President of the Torquay School of Science and Art.)

As President of one of the Government schools of science and art in this neighbourhood, I am desirous of inviting attention to this very important branch of national education, especially in the county of Devon; but before doing so, I would offer a few remarks on the real nature and objects of art, founded upon the address of our late President.

"I agree with Mr. Mill," said Sir J. D. Coleridge, "that 'science, art, and letters are all essential contributaries to a complete education.' They depend on and assist each other, so that to the perfection of either (at least in idea) the presence of the other two, to some extent and degree, is necessary and essential. It appears, indeed, a truism to say of science that it is engaged in the pursuit of truth, and that truth is its main object. Now this is true of art, but with a difference; for truth in art is something different from truth in science. Artistic truth is not mere external truth, truth only of representation. Mere imitation, however dexterous, so dexterous as even to be deceptive, is not art; nay, I am bold to say, though it sounds paradoxical to say so, has nothing to do with art. No one ever walked up to a portrait by Titian, by Rembrandt, by Sir Joshua, and mistook it for a living man. Many have mistaken the figure of Cobbett at Madame Tussaud's waxwork for an actual human being. No one was ever deceived by the flowers or the fruit of Van Huysum, or Müller, or William Hunt; every one has, I suppose, in his time been deceived by skilful waxwork or painted stone ware of these things. Yet who calls waxwork art? or who, save the most childish, derives the smallest mental pleasure from it? It has been suggested, I believe by Coleridge, that where there is no attempt at deceptive imitation, every approach to likeness gives an intellectual pleasure; but that where the imita-

tion is actually deceptive, every dissimilitude when it is discovered excites disgust. I do not pretend to assert that this is the philosophy of it; but the fact, in painting, undoubtedly is so. Truth in art, therefore, is truth of thought and truth of expression. It is ideal truth, not actual. And this ideal truth has, as it seems to me, been lost sight of, and the real value of art has been in consequence much lowered in pursuit of minute imitation of external forms." He attributes much of this to photography, and severely criticises Mr. Holman Hunt's "The Light of the World," and "Our Lord in the Temple." "I suppose," he adds, "a picture should, if possible, affect the mind as the reality which it depicts would affect it if the reality could be seen. Now who in the presence of 'The Light of the World' would have eyes for the jewels on His lantern, or the moonlight on the ivy leaves behind Him? Who that saw 'our blessed Lord in the Temple' would have patience or heart to trace the illuminations on the rolls of the manuscript, or the patterns on the phylacteries of the doctors? There is not a great man who has not repudiated imitation, and aimed at, and often realized, that higher and nobler truth, which is to be gained only by sacrifice of detail, and, if you will, by convention."

The principles to which I take exception in these otherwise admirable remarks are the unqualified condemnation of the realistic, as displayed in two pictures of widely different character, and the approval of "convention" as a medium of artistic expression. The true objection to "The Light of the World," I would rather suggest, is, that the original idea is faulty. If it were conceivable that our Lord would ever have appeared in that wonderful satin dress, and carried a jewelled lantern, every minute detail would have been as essential as the urim and thummim in the vestments of the typical High Priest. There is an utter confusion between the real and the ideal. "Behold, I stand at the door and knock," is in the spirit—on the heart. To give a policeman the features of the *effigies smaragdine incisæ* of the Saviour, is to mistake similarity for identity, allegory for fact. The details in this instance are not merely superfluous, but false. "Our Lord in the Temple," on the contrary, is a historical scene; and if "a picture should, if possible, affect the mind as the reality which it depicts would affect it," and if "a literal transcript, a photograph of our Lord on the Mount, or among the doctors, would be beyond all price," we have here the nearest practicable approach to it. Modern books and

English pigeons would have been an anachronism ; and "the illuminations on the rolls of manuscript, the patterns on the phylacteries of the doctors, the costume and architecture of the East," even "doves brought from Palestine instead of Covent Garden, in order to make the accessories of the picture literally and minutely accurate," were, if true, not "a childish waste of time and money," but praiseworthy.

Undoubtedly a picture should not be a mere transcript, but an interpreter of Nature. Art is essentially eclectic. Even in photography an artist's eye is needed in the choice of subject. The draughtsman may go beyond this. "Artist's license" may ignore not only what is objectionable, but all that detracts from the unity and force of the leading idea. If attention is to be concentrated upon form, mere outline will best effect it ; chiaroscuro is most effective in neutral tint ; but full colour demands detail and finish, if nature and truth are to be our guides.

Some very sensible remarks on imitation and high finish were made by one of our members (Dr. Scott) at the annual meeting of the Exeter School of Art, in 1864. "There was a little difference," he said, "between artists as to how far detail should go. The pre-Raffaellites said, artists must be very careful in imitation. No doubt imitation was necessary, but it was imitation of a kind ; it was imitation *sub modo*, as the lawyers said. Imitation of an object possessing breadth, thickness, rotundity, and solidity on a flat surface was impossible, in a strict point of view. In such imitation they had the feeling and representation of the object in the mind, on a flat surface ; and the only way that could be done was by light and shade ; what artists called breadth was the effect desired. When he first learned to draw, he tried to imitate every hair on the head, and this was what might be called the perfection of imitation in great detail ; but they would never get human hair artistically represented in that form. The greatest artists gave the hair in light and shade, as seen in the living man, with a little detail here and there, to suggest what the mass was." Ruskin quotes from Wordsworth—

"Would that the little flowers were born to live
Conscious of half the pleasure which they give,
And to this mountain daisy's self were known
The beauty of the little star-shaped shadow thrown
On the smooth surface of this naked stone."

And adds, "That is a little bit of good downright foreground painting—no mistake about it ; daisy and shadow, and stone,

texture, and all. Our painters must come to this before they have done their duty; and yet, on the other hand, let them beware of finishing, for the sake of finish, all over the picture. The ground is not to be all over daisies, nor is every daisy to have its star-shaped shadow. There is as much finish in the right concealment of things as in the right exhibition of them”*

If a large painting is for distant effect, coarse, bold treatment will be not only sufficient, but the most effective; a miniature should rival a photograph. The technical *distance of the picture*, i. e., the angle which it should subtend, so as to cover the portion of nature which it represents, should be the guide. “The Light of the World” is much too large for microscopic treatment. If examined close enough to see the daisy with its star-shaped shadow, the perspective of the main figure is distorted, and the true effect lost. A companion picture, “The Return of the Dove to the Ark,” which I recently saw with it at the New Clarendon, Oxford, has the same defect: the miniatures of hay and rubbish in the corners, which ought always to be left unobtrusive, looked as if derived from the packing case.

The special charm of a rough sketch by a master’s hand—“the frescoes of Fra Angelico, or the cartoons of Raffaele”—arises from quite another source—the triumph of art without apparent effort; there is also the supplementing of details by the imagination, and the *ignotum pro magnifico*, to be measured not only by the skill of the artist, but of the connoisseur. I was once complimented by an eminent sculptor for not admiring the Elgin marbles; he could reconstruct the frieze of the Pantheon, I, at first glance, could only see the *disjecti membra sculptoris*. The uneducated eye delights in high finish. In Harding’s sketch it can only see the outline; an artist, as he observes, can see the goose. But this is not conventionalism, but “elementary art.”

When Sir Joshua Reynolds sanctions a stereotyped formula for rock and tree, irrespective of specific character, he degrades his backgrounds into a portion of the picture frame; but when even Ruskin pronounces mediæval conventionalisms, the tresfoil or quatrefoil as preferable to the sculpture of natural foliage for ecclesiastical purposes, he is on the high road to fetish-worship. The gurgoyles on some of our Christian churches would be gods in India, and worshipped as demons in the mountains of the moon. *Punch* pronounces the cherubs on our village tombstones to be a new genus—“The tailless birds of Paradise.”

* “Modern Painters,” part ii. sec. 1, c. vii.

It should never be forgotten that true graphic art addresses itself exclusively to the eye, as music does to the ear, fragrance to the olfactory nerves, and gustation to the palate of the gourmand. Conventionalism and arbitrary symbols of any kind can reproduce, but never originate, ideas. They soon become a hieroglyphic, then a monogram, and finally an alphabet speaking direct to the mind. But this is literature, not art.

In the last Report of the Science and Art Department to the Committee of Council on Education, full information is given as to the advantages offered to local schools, and their results, up to the close of the year 1868.

1. Aid is given towards the promotion of instruction in science applicable to industry.

2. Aid is given toward the promotion of instruction in elementary drawing as a part of national education, and in fine art as applied to industry.

3. The central repository at the South Kensington Museum for objects of science and art is, as far as practicable, made available throughout the United Kingdom.

The following are the numbers of SCIENCE SCHOOLS, and the students under instruction in each year, since the passing of the General Science Minute :

	Schools.			No. under instruction.		
1860	...	...	9	...	...	500
1861	...	...	38	..	...	1,300
1862	...	...	70	...	...	2,543
1863	...	...	75	...	...	3,111
1864	...	...	91	...	...	4,666
1865	...	...	120	...	...	5,479
1866	...	...	153	...	...	6,835
1867	...	...	212	...	...	10,230
1868	...	...	300	...	...	15,010

In some instances a school consists of but one class, and there is but one subject taught; in others there are 10 or 12 classes in different subjects. The total number of classes in 1868 was about 780. Students in these classes to the number of 6,875 came up for examination, besides 217 self-taught students, and pupils of classes not under teachers qualified to earn payments on results. The following are the results :—

	No. examined.	No. of papers worked.	No. of papers passed.	Prizes.
1866	... 2,980	.. 5,466	... 3,562	... 2,071
1867	... 4,520	... 8,213	... 6,013	... 3,453
1868	... 7,092	... 13,112	... 8,649	... 5,246

The payments to teachers in the year 1868 amounted to £12,725 10s., being at the rate of 16s. 10d. for each person under instruction. The number of teachers paid was 285, the payments varying from £1 to £243 10s., the average being about £44 13s. per teacher. The grants towards purchase of apparatus, &c., amounted to £236 2s. 5d.; also prizes and medals to the value of £1,039.

Since the close of the report for 1868, the returns of a month in the present year show that the number of the Science Schools had increased to 514; of these 354 were in England, 28 in Scotland, and 132 in Ireland. This is an increase of 234 schools and about 9,500 students on the corresponding returns last year, irrespective of the Navigation Schools, which do not send up pupils for examination.

The number of SCHOOLS OF ART in the year 1868 was 101, containing 18,479 students, being an increase on the year of 1,138. There has been an increase of 321 students whose works were found satisfactory at the annual examination, and of 901 in the number of those who had been successful in the personal examinations of the second grade. The Night Classes, where no regular school exists, have increased from 72 to 130, giving instruction to 4,466 students; and the teaching of drawing has now extended to 784 of the schools for the poor, and 79,411 children.

There were 2,035 candidates examined for teachers of Elementary Schools, of whom 1,590 obtained partial success, and 190 gained certificates.

The payments on results for students who had submitted to examination amounted to £54,096. The total number of prizes awarded were 9,780, in addition to 10 gold, 20 silver, and 50 bronze medals, with 47 Queen's prizes of books.

By the Minute of Council in 1867 exhibitions and scholarships were founded both in science and art, in addition to which eight of Mr. Whitworth's exhibitions have been made local, with four established by the Board. Thirty-one elementary school scholarships have been established and awarded, and fifty-three science and art scholarships have been given on the results of the May examination. A local contribution of £5 is now required in each case for the purpose of enlisting local action, and affords a guarantee that the State grant is properly applied.

Mr. Whitworth's munificent foundation of sixty exhibitions of £25 each has given rise to much competition in the higher classes of mechanics.

The most popular subjects in science, as shown by the number of papers worked during the past year, were:—Mechanical and Machine Drawings, 1,671; Physical Geography, 1,516; Elementary Mathematics, 1,390; Practical, Plane, and Solid Geometry, 1,337; Building Construction, 1,185; Animal Physiology, 1,182; Acoustics, Light and Heat, 1,038.

The reports of the examiners contain much that is suggestive. Professor Bradley comments upon the too exclusive use of Euclid's Elements as of little use in Solid Geometry; and disregard of *symmetry*. "Machinery," he says, "would not work, nor their structure stand, as many of the students represent them." Professor Frankland reports that the papers on Chemistry were upon the whole very satisfactory; but some students are "content with defining an acid as 'that which combines with a base,' and a base as 'that which combines with an acid,' and a salt as a combination of the two." In Geology, Professor Ramsay considers that "the majority of the pupils have been very fairly taught;" but "there is a general tendency to attribute all the irregular features of ground, and especially mountain chains, to earthquakes and volcanic eruptions, and also to describe various old phenomena as '*gigantic*' where there was nothing specially large about them." Professor Huxley, in Animal Physiology, is severe upon bad spelling, and "grinding instead of instruction." "A great many papers exhibit the results of very careful and conscientious teaching, the only fault of which is, that it has obviously been all book work." He recommends live frogs and "subjects" from a butcher's shop. In Physical Geography, Professor Ansted reports that "the number of really good papers sent in is greatly increased."

SCIENCE SCHOOLS IN DEVON.

	Number of Individuals under Instruction. 1867-8.		Number of Prizes. 1867-8.	
	...	...	...	...
DARTMOUTH—Mutual Improvmt. Society...	...	26	...	6
EXETER—Albert Memorial Museum	37	32	15	11
KINGSBRIDGE—Town Hall	12	17	7	...
PLYMOUTH—Courtenay Street	154	163	63	81
TAVISTOCK—British Schools	50	50	...	22
TORQUAY—School of Science and Art.....	36	63	13	28

SCIENCE SCHOOLS IN DEVON.

	Number of Individuals under Instruction.			Number of Prizes.		
	May 1867.	May 1868.	March 1869.	1867.	1868.	1869.
BARNSTAPLE—Literary and Scientific Institution	...	...	60	...	...	
DARTMOUTH—Mutual Im- provement Society	...	26	33	...	6	
DEVONPORT—Mechanics' In- stitute	...	...	9	...	...	
EXETER—Albert Memorial Museum	37	32	31	15	11	
KINGSBRIDGE—Town Hall ...	12	17	15	7	...	
PLYMOUTH—Courtenay Street	154	163	146	63	81	
„ Buckwell Street	18	13	9	3	6	
„ Navigation School	...	344	23	...	...	
„ Charles' National School	...	...	90	..	...	
TAVISTOCK—British School...	...	50	72	...	22	
„ National School	...	...	59	...	...	
„ St. Mary Tavy	...	...	14	...	...	
„ Gulworthy School	...	34	68	...	9	
TORQUAY—School of Science and Art	36	63	48	13	28	
Total Devon	257	742	677	101	163	
United Kingdom	8859	14068	21590	2299	3650	

The subjects taught in the Devonshire Science Schools were:—

BARNSTAPLE—Elementary Mathematics.

DARTMOUTH—Elementary Mathematics, Nautical Astronomy, Navigation, Acoustics, &c.

DEVONPORT—Vegetable Anatomy, Systematic Botany.

EXETER—Elementary Mathematics, Inorganic Chemistry, Geology, Systematic Botany, Animal Physiology, Vegetable Anatomy.

KINGSBRIDGE—Animal Physiology.

PLYMOUTH—Geometry, Mechanical Drawing, Naval Architecture, Physical Geography, Mathematics, Mechanics, Acoustics, Magnetism, Chemistry, Animal Physiology, Zoology, Vegetable Anatomy, Botany, Navigation, Steam, Electricity.

TAVISTOCK—Elementary Mathematics, Acoustics, Magnetism, Inorganic Chemistry, Animal Physiology, Machine Construction and Drawing, Steam, Physical Geography.

TORQUAY—Acoustics, &c., Magnetism and Electricity, Animal Physiology.

The choice of subjects depends as much upon the master as the pupils, and varies in successive years. The following is the proportion of the several classes throughout the United Kingdom:—

	Total Number of	
	Classes.	Students.
1 Practical, Plane, and Solid Geometry .	158	4455
2 Machine Construction and Drawing .	153	4416
3 Building Construction or Naval Architecture	129	3632
4 Elementary Mathematics	153	3001
5 Higher Mathematics	5	33
6 Theoretical Mathematics	53	1124
7 Applied Mathematics	16	338
8 Acoustics—Light and Heat	93	2305
9 Magnetism and Electricity	132	4076
10 Inorganic Chemistry	152	4384
11 Organic Chemistry	25	981
12 Geology	41	967
13 Mineralogy	8	159
14 Animal Physiology	129	3569
15 Zoology	15	452
16 Vegetable Anatomy and Physiology .	19	283
17 Systematic and Economic Botany .	9	226
18 Mining	3	79
19 Metallurgy	13	243
20 Navigation	22	1165
21 Nautical Astronomy	12	951
22 Steam	5	128
23 Physical Geography	111	3548
Totals	1456	21,490

ART SCHOOLS IN DEVON.

	Students.	Examined	Successful	Successful Artisans.	2nd Grade Prizes.	3rd Grade Prizes.
Devonport ...	108	33	22	17	4	3
Exeter ...	283	93	58	31	15	4
Torquay ...	150	37	25	19	6	2
Total Devon ...	541	163	105	67	25	9
Total United Kingdom } 108 Schools	18474	6478	3961	2533	884	516

	Subscriptions, Department Aid, &c.	Morning Classes.	Evening Classes.	Total Income.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Devonport ...	71 5 0	37 11 0	22 3 0	130 19 0
Exeter ...	205 19 0	170 14 0	163 1 6	539 14 6
Torquay ...	129 10 0	119 9 9	22 16 0	271 15 9
Total Devon ...	406 14 0	327 14 9	208 0 6	942 9 3
Total United Kingdom	13440 13 6	10616 12 8	6352 3 13	1956 10 6

**INSTRUCTION IN DRAWING IN SCHOOLS FOR THE POOR,
IN DEVON.**

	No. of Children Taught.	Number Passed.	
			£ s. d.
BARNSTAPLE—			
Wesleyan School	60	35	5 19 0
DEVONPORT—			
Royal Naval and Military ...	360	172	13 6 0
St. James' National School ...	170	103	8 7 0
EXETER—			
Devon & Exeter Central Sch.	100	30	3 9 0
Episcopal Charity School ...	115	54	6 17 0
Hele's School	163	61	7 7 0
Wesleyan	77	44	6 2 0
St. David's Boys'	121	31	4 12 0
St. John's Hospital	200	102	13 2 0
PLYMOUTH—			
Charles' National School	320	54	7 5 0
George Street Day School ...	95	76	8 0 0
Public Free School	750	461	35 18 0
St. Andrew's National School	180	81	8 5 0
„ Chapelry School.....	50	36	3 19 0
STOKE—			
Public School	140	98	9 18 0
TAVISTOCK—			
British School	170	85	6 16 0
Gulworthy	100	89	8 12 0
TORPOINT—			
Boys' National School.....	72	42	5 13 0
TORQUAY—			
British School	120	56	5 13 0
Total Devon	3363	1710	168 11 0
Total United Kingdom			
778 Schools	93713	46702	4911 10 0

The old philosophical definitions of science and art, *ἐξ ὑποθέσεως θεωρητικὴ* and *ἐξ ὑποθέσεως πρακτικὴ ἢ ποιητικὴ*, one the theory, the other the practical application of the laws of nature, have lost their significance in modern phraseology. Fine art embraces both science and art in the original meaning of those terms. The *Γραφικὴ* which Aristotle made a branch of popular education was both the science of beauty and the art of design. He commends it as developing the perceptive faculty; and so intimately was beauty then connected with the useful arts, that he advocates the cultivation of what we denominate the fine arts, as improving the national taste in regard to industrial products.

This feature, which easily degenerates into the mercenary question of trade values, is now too generally advocated as the almost exclusive object of the government schools. Its importance cannot be denied. It affords the option of higher wages or shortened hours of labour; but, beyond this, the element of beauty and good workmanship lightens the drudgery of toil, and the skilful artificer feels an abstract pleasure in success. Toil has been variously regarded as a blessing and a curse. Dryden thus apostrophizes it:

"Offspring of woe, but parent of our ease,
The toil that teaches pleasure's self to please,
Allays the grief which spurns direct control,
And stills the raging tempest of the soul."

The most plausible objection to popularizing science and art is, that they necessarily become superficial, and study degenerates into cramming. "Drink deep or taste not" is a fallacy. The merest smattering of true knowledge is better than none. Lord Palmerston very sensibly argued that scattered facts soon attained cohesion, and for ordinary unprofessional purposes the desultory lectures of the Hartley Institute, which he was inaugurating, were often a more fruitful germ of future excellence than any exclusive and more methodical line of study. What is it that ordinarily distinguishes the educated from the uneducated classes? What is meant by general information, but the most cursory view of the grand circuit of human knowledge?

This is not the occasion for dilating upon such a theme; but it is very instructive to trace the very close but somewhat paradoxical connection between work and play. Agriculture, mechanics, and decorative art, have their counterpart in the occupations of the wealthy. Modern sport is the representative of the hunter age; yachting is high art in

navigation; and the member of Parliament or county magistrate finds an absorbing interest in unpaid official duties. The parallel is still more complete if we observe how deeply innate in the human breast is the love of gain. The wealthiest rejoice in a successful speculation, and games of chance or skill are vapid if played for love. Patrimonies more than sufficient for every want are risked for the mere excitement of gambling.

If such be human nature, our schools of science and art have a double value—the *utile dulci* is complete, and the humblest mechanic can share the enjoyment, and, I may add, the dignity, of the members of the Devonshire Association—the *ενεργεια ψυχης κατ' αρετην την αριστην, ετι δε εν βιο τελειω*.

THE LITERATURE OF KENT'S CAVERN.

PART II.

INCLUDING THE WHOLE OF THE REV. J. MAC. ENERY'S
MANUSCRIPT.

BY W. PENGELLY, F.R.S., F.G.S., ETC.

AT the meeting of the Association held at Honiton last year (1868), I had the pleasure of reading the first instalment of a paper on "The Literature of Kent's Cavern," which closed with the following words:—"So far as I have been able to ascertain, the foregoing are the only notices of the Cavern which had appeared prior to 1859, when Mr. Vivian published Mr. Mac Enery's Manuscript, and thereby opened what may be called the Second Chapter in the Literature of Kent's Cavern. The exigencies of time and space warn me that this important Memoir, and the Reports by the Committee appointed by the British Association, must be deferred to some future occasion."*

In accordance with the intention shadowed forth in this passage, I now resume the topic; but before entering on Mr. Mac Enery's Memoir it is desirable to call attention to a few comparatively brief notices which should have been incorporated in the First Part of my paper, but with the existence of which I have but recently become acquainted.

PLAN OF THE MANOR OF TORMOHAM. 1769.

I stated last year that the earliest known mention of the Cavern occurred in Dr. Maton's *Observations on the Western Counties of England, made in 1794 and 1796*.† The following fact, however, shows that the Cavern was well known upwards of a quarter of a century earlier:—There is in the office of Messrs. Kitson, Solicitors, Torquay, an old map, dated 1769, entitled "A Plan of the Manor of Tormoham in the said Parish

* Trans. Devon. Assoc. (1868), vol. ii. p. 522.

† Ibid. p. 470.

and Parish of Whitechurch in the County of Devon the property of Robert Palk, Esq. Mr. Blackmore surveyd and Delineated."

In this plan, the entire Manor is divided into plots or fields, of which the names are given : and one of them is designated "Kent's Hole Field."

It may be inferred that the Cavern had not then been recently discovered, since it was so well known as to give the name to the field in which it stood.

In all probability the records of the Manor contain still earlier mentions of it.

MR. W. HYETT, 1803 ?

Hyett's "Description of the Watering Places on the South East Coast of Devon," has recently been brought under my notice by Mr. R. Dymond of Exeter, who informs me that the work is not mentioned in *Bibliotheca Devonensis*. Unfortunately the book is without date ; but, from internal evidence it appears to have been written late in the last, or very early in the present century ; certainly not later than 1803.

In his "*Ride from TORQUAY to NEWTON BUSHEL*," the author says, "Taking the road opposite the quay, we are brought, amid undulating hills, to *Torwood*, a fine old building belonging to *Sir Lawrence Palk*, and standing in a very pleasant situation ; about half a mile beyond this, a gate, facing the road, opens into a spacious field, the lower part of which, (a coppice) contains that celebrated cavern, *Kent's hole*, the aperture of which is not of any great magnitude, and is almost shrouded in bushes. As I was, a few months since, procuring a guide, to explore the gloomy recess, (I mention the fact as a caution to the unwary) a young naval officer, attended by a labourer, with a lantern, tinder-box, &c. overtook me, who, accosting me, observed, if I would accompany him, *he hoped to show me a resurrection* ; at my entreaty he explained himself, by saying that five of his brother officers, belonging to a ship in the bay, had that morning entered the cave, without the precaution of taking a guide, and had carried with them a quantity of port-fires, the voluminous smoke of which had extinguished the only candle they had ; and when their momentary glare was exhausted, they were left almost suffocated with smoke, in total darkness ; having exhausted their strength and patience in fruitless efforts to find the way out of its dreary intricacies, they gave themselves up to despair ; when he, having parted from the rest, guided by his good genius, at length emerged

into the cheering light of day.* Having augmented our guides, we entered the chasm, with each a candle, and cautiously proceeded, as it was remarkably rough, and would scarcely allow sufficient height to stand erect; after a short descent, it opens into a sort of hall, more spacious and lofty; the blaze of our lights dissipating enough of the gloom to expose the ponderous jaws of many a horrid orifice on either side; our path now became somewhat smoother, and permitted us to examine the many whimsical petrefactions and incrustations nature had secreted in these Cimmerian shades, on the approach of the light to the roof, innumerable gems sparkled as it passed, with beautiful radiance. After some time, the unfortunate objects of our search answered our repeated shouts, and, directed by the sound, we found the disconsolates, seated round the margin of a limpid pool (whose waters forbade a farther disclosure of its secret recesses) almost exhausted with fatigue, but the happy prospect of a release, from what they had almost concluded would have been their grave, gave them new animation, and I soon had the pleasure of congratulating them on their return to the world, from which they had been more than six hours secluded."†

MR. GOUGH. 1806.

Mr. Storey, of Torquay, has kindly reminded me that in his edition of Camden's "Britannia," Mr. Gough says, in his "Additions:"—

"On the side of the bay" (Torbay), "diagonally opposite to Brixham, is a remarkable excavation called *Rents Hole*. The great cavern (for there are many subordinate ones) is about 93 feet deep, 100 wide, and about 30 in height in the loftiest part. It is inferior therefore to the Derbyshire caves in extent and loftiness, and to Wokay in the latter respect, though more extensive"‡

Brixham commands a view of Hope's Nose—the northern horn of Torbay;—and when compared with the line joining these points, "the side of the bay diagonally opposite to

* This, in all probability, is the party of naval officers mentioned by the anonymous author of "A Guide to all the Watering Places," 1803. See "Trans. Devon. Assoc. for Advancement of Science, Literature, and Art," vol. ii., p. 474. 1868.

† "A Description of the Watering Places on the South East Coast of Devon, from the River Exe to the Dart inclusive, comprehending Dawlish, Teignmouth, Shaldon, and Torquay." By W. Hyett. Exeter: Trewman and Son.

‡ "Britannia." By William Camden. Translated from the Edition published by the Author in 1607. Enlarged by the latest Discoveries. By Richard Gough. Second Edition, in 4 vols. 1806. "Additions," vol. i. p. 52.

Brixham," is by no means an inapt description of the position of Kent's Hole, of which "Rent's Hole" is, of course, a misprint.

It is, perhaps, worthy of remark that the dimensions given by Mr. Gough are identical with those stated by Mr. Polwhele in his *History of Devonshire*, published in 1797.*

THE MONTHLY MAGAZINE, 1825.

The following notice occurs in the *Monthly Magazine* for March, 1825, under the heading of "Provincial Occurrences, Devonshire :"—"*Organic Remains in Kent's Hole, and Chudleigh Cave.*—The celebrated Professor of Mineralogy and Geology in the University of Oxford, Mr. Buckland, has been on a visit to Lord Clifford, in company with Sir Thomas Acland, and has examined the cave at Chudleigh, known by the name of the Pixy's Hole; here he penetrated the stalagmite, and sunk to the depth of three or four feet, and found various remains of antediluvian animals: such as the hyæna, the deer, the bear, &c. The depth of the den where these remains are found is a matter only of conjecture, but the discovery is, we understand, to be followed up. The Professor has also visited Kent's Hole, and commenced his operations in the two caves where Mr. Northmore had made his original discoveries; among other treasures we hear that Mr. Buckland discovered the blade of a knife belonging to the ancient Britons, made of flint, about two inches and a half long, and half an inch broad. The public, we understand, are likely in the course of the present year, to have the gratification of perusing an account of these antediluvian curiosities in the expected new edition of Mr. Buckland's work, if not also from the pen of Mr. Northmore."†

PROFESSOR BUCKLAND. 1826.

The "Edinburgh Philosophical Journal" for April, 1826, contains the following article:—

"*Professor Buckland's Notice of the Hyæna's Den near Torquay.*—Professor Buckland has lately sent to Professor Jameson, for the College Museum, several specimens of bone from the hyæna's den at Kent's Hole, near Torquay, all of which he considers as bearing most decided marks of teeth and gnawing upon them. Three of these bones (Nos. 4, 5, 6,) are splinters, which appear to have been gnawed and nibbled

* See Trans. Devon. Assoc., vol. ii. p. 472. (1868).

† "The Monthly Magazine; or British Register." London, vol. lix. pp. 190-1. 1825.

over and over again, after they were split off from the cylindrical bones, of which they formed a part. Other splinters have not been gnawed after such fracture; but of these none have been sent at present.—Professor Buckland's sole object being to produce conviction in those who deny the fact of the marks of teeth and gnawing being visible on the bones found in our English hyænas' dens. Numbers 1, 2, 3, are portions of cylindrical bones, from which both extremities or condyles have been gnawed off at a period antecedent to that when they, as well as the splinters and teeth that accompany them, were imbedded in the mud and gravel that now surround them. Of more than a thousand bones, or rather fragments of bones, that have been collected recently in Kent's Hole, not fifty have been found entire. The condyles, and softer portions, are almost uniformly removed, and marks of gnawing and fracture, such as appear in Nos. 1, 2, and 3, are generally visible at the extremities of the remaining central and harder portions. The condition of the teeth,—the number and varieties of the animals,—and the circumstances that accompany their mangled remains, are precisely the same as at Kirkdale; the only difference is, that at Torquay, the cave is more than twenty times as extensive as that in Yorkshire; and the remains of all kinds, nearly in the same proportion more numerous. The superficial crust of stalagmite, and the bed of mud which forms the matrix of the broken bones and teeth beneath it, are also in the same proportion thicker. There are also *album græcum*, as at Kirkdale, and stumps of gnawed horns of deer; and the bony bases of horns of rhinoceroses, but no *horns of this animal*, although more than a hundred of its teeth have been already found; also the teeth of many infant elephants,—numberless bones of horses, elks, deer, and oxen.—and gnawed bones and jaws of hyænas, with their single teeth and tusks; also the teeth and tusks of bears, tigers, wolves and foxes,—and of an unknown carnivorous animal, at least as large as a tiger; the genus of which has not yet been determined. All these will be described in Professor Buckland's second volume of *Reliquiæ Diluvianæ*. The history of the Torquay cave being, according to Professor Buckland, intential with that of Kirkdale, is totally different from that of the cavernous fissures at Plymouth and Banwell; both the latter containing bones that are usually entire, and never gnawed; and which appear to have been supplied by animals that fell into the open fissures, before they were filled with the mud and gravel that now envelope their bones.”*

* “Edinburgh Philosophical Journal,” vol. xiv. pp. 363-4. (1826.)

DR. TURTON AND MR. KINGSTON 1832 or 1833?

The second volume of the *Teignmouth Guide*, published probably about 1832 or 1833, was the joint production of the late Dr. Turton and Mr. J. F. Kingston, and contains the Natural History of the neighbourhood. The following brief notice of the Cavern occurs in the section devoted to Geology:

"Fissures and Caverns of this kind are of general occurrence in compact Lime rocks, not only in this Island, but on the Continent where they have long been objects of curiosity; the most remarkable ones in our district are those of Kent's Hole and the Chudleigh rocks, the former of which has been very diligently explored, and we are looking forward with great interest, to the publication of a work that has been announced by a gentleman of Torquay, which will contain an account of the Treasures that have there been unearthed. They are all more or less filled with a Diluvial detritus of mud, sand, angular fragments of Transition rocks, &c., and stalactites."

"These cavernous fissures have all a communication with the surface, and, as previously stated, are of general occurrence in Lime rocks, whilst the dispersion of bones in them is only partial; those that have occurred within our district, are we believe chiefly referable to the following animals, Hyæna—Tiger—Bear—Wolf—Fox—Rhinoceros—Horse—Ox, Deer, and some smaller animals of the natural order, Rodentia."*

REV. J. MAC ENERY.

In 1859 Mr. Vivian edited and published portions of Mr. Mac Enery's Manuscript under the title of "Cavern Researches,"† and gave the history of the Manuscript itself in the following *Preface*.

"The following Memoir is compiled from the original manuscript notes of the late Rev. J. Mac Enery, for many years Chaplain at Tor Abbey, by whom the cavern was first explored. From the Prospectus it appears that, when completed it was to have been illustrated with thirty plates, by Scharf, representing the fossil remains of the natural size, with sections and ground plans of the principal caverns, 'the limited circulation of works of this nature, however, being by no

* "Teignmouth Guide, Part 2—The Natural History of the District." By W. Turton M.D. and J. F. Kingston—Teignmouth. (The book is neither dated nor paged.)

† "Cavern Researches, Discoveries of Organic Remains, and of British and Roman Reliques, in the Caves of Kent's Hole, Anstis Cove, Chudleigh and Berry Head." By the late Rev. J. Mac Enery, F.G.S. Edited from the Original Manuscript Notes, by E. Vivian, Esq. 1859.

means equal to the expenses attendant upon the execution of so large a series,' the Author, after a second appeal was compelled to abandon his design. At his death the vast and invaluable collection of fossil remains was sold by auction, and, unhappily, dispersed; the manuscript was purchased in a lot of sermon notes and other papers by the late Mr. Lear, of Lawrence Place "[Torquay]." It was for many years overlooked and supposed to be altogether lost to science. . . .

. Having accidentally discovered that the greater portion of the Memoir was in the possession of Mr. Lear, I published some extracts in the Torquay Directory. It was subsequently purchased, with Mr. Lear's cabinet of fossils, by W. Long, Esq., F.G.S. "[of Saxmundham, Suffolk]," who most liberally presented it to me with a view to its publication. The manuscript is in a very imperfect state, consisting of fragments of the original notes, a portion being rewritten several times with considerable alterations. In order to preserve the freshness of first impressions, and the exact statement of Mr. Mac Enery's views, I give it, as far as possible verbatim, scrupulously making no addition, and only omitting those passages which are in duplicate or irrecoverably mutilated, and readjusting the whole, as far as practicable, in a connected series.

"Of the plates above referred to, sixteen were executed at the expense of the late lamented Dean of Westminster, and by the liberality of his son F. Buckland, Esq. (2nd Life Guards), I have been permitted to have some proof impressions taken, to illustrate large paper copies.

(Signed)

E. VIVIAN.

"Woodfield, Torquay,
1st Jan., 1859."

To complete the history of its wanderings, it is only necessary to add that, in 1867, Mr. Vivian presented the Manuscript to the Torquay Natural History Society, whose property it now remains. The Committee of this body having, with Mr. Vivian's concurrence, kindly permitted me to publish it, I have been induced to prepare it for the press, in the hope that, notwithstanding its bulk, the Council of this Association may be willing to give it a place in their "Transactions."

The Manuscript is accompanied by a *Prospectus* of which an exact copy is given on the next page.

Shortly will be published, in one volume Quarto,

CAVERN RESEARCHES;

OR,

DISCOVERIES OF ORGANIC REMAINS,

AND

OF BRITISH AND ROMAN RELIQUES,

IN THE CAVES OF KENT'S HOLE, ANSTIS' COVE, CHUDLEIGH, AND BERRYTHAL

ILLUSTRATED WITH PLATES,

Representing the subjects of the natural size, by SCHAEFF; including Views, Sections, and Ground Plans of the principal Caves.

BY THE REV. J. MAC. ENERY, F. G. S.

NON. MEM. OF THE YORKSHIRE, BRISTOL, &c. &c. PHIL. &c.

In consequence of the great accession of specimens of the various remains above enumerated, and a desire not to exclude any, that may conduce to a complete history of these abodes of successive generations of beings from the earliest period, it has been found necessary to extend the number of plates to thirty. The limited circulation of works of this nature, being by no means equal to the expences attendant on the execution of so large a series, the author is obliged to depart from his original plan, and to solicit the support of those who may feel an interest in the result of his researches.

Subscriptions received at Cole's Library, TORQUAY, where specimens of the plates may be seen.

The Manuscript was probably written at intervals extending over several years. Some portions of it are certainly not older than the year 1836, as Dr. Buckland's *Bridgewater Treatise*, published in that year, is quoted several times; and no portion can be assigned to a later date than 1840, as the author's decease took place on February 18th, 1841.*

It may be said to consist of ten fasciculi, which I have designated A, B, C, D, E, F, G, H, I, and J. The last consists of a series of Scraps, Notes, and Memoranda. The others take the form of separate Narratives or Essays, in which the Cavern and the discoveries made in it are described, and their bearings on Palæontology, Archæology, Anthropology, and Theology are discussed.

They are all in a more or less imperfect condition:—thus, they contain numerous original lacunæ; several pages are missing here and there; in several instances the author has set down the heads of topics only, instead of that which he intended to write respecting them; sometimes he has written a memorandum in an interrogative form, apparently as a reminder that he needed information on certain points; and not unfrequently after writing a word or a sentence, he has written a second, to the same general effect, immediately above the first, and has left both of them unerased as if undecided which to employ.

It was the author's wont to write on one side of the paper only, but, in the pagination, to enumerate the blank as well as the occupied pages. Occasionally, however, new sentences or paragraphs are written on the former with indications, frequently obscure, that they are to be incorporated in the narrative or essay, at a certain place, perhaps in the adjacent page, or perhaps on a distant one.

Occasionally the "blank" pages are occupied with miscellaneous notes or memoranda for whose incorporation no indication is given, and which do not appear to be very closely connected with the subjects immediately under discussion.

Mr. Vivian's edition of "*Cavern Researches*" is illustrated with seventeen plates, instead of sixteen as he states. They are defined, not with numerals, but with the letters of the alphabet from B to T inclusive, J and O being omitted. The first sixteen contain figures of the remains of animals, and the seventeenth of flint implements. They all state that the specimens represented on them were found in "Kent's Hole Torquay;" fourteen of them, that they were "lithographed from Nature by G. Scharf;" one, F, that it was delineated by

* See his gravestone in Torre Church Yard, Torquay.

"Mary Buckland" and lithographed by "G. Scharf;" the remaining two, H and I, are silent on this point; F alone states the date on which the specimens figured in it were found—"Jany. 1826;" twelve give the information that the specimens were found by Revd. J. MacEnery, one, C, by Revd. L. P. Welland, whilst the remaining four are silent; in thirteen the figures are the "Nat. Size;" three, " $\frac{1}{2}$ Nat. Size;" and of one, N, no statement is made.

During the present year (1869) a series of plates, obtained through one of the executors of the late Mr. Mac Enery, was presented to the Torquay Natural History Society by Messrs. Gardner and Greenfield of Torquay. Many of them are copies of those just described, but with them are two new ones apparently belonging to the same set. They are defined as Plates O and U,—the latter a continuation of the series, and the former filling a hiatus in it. O contains twenty-one figures of remains of animals found in "Kent's Hole Torquay," U, seventeen of "Knives and Arrow Heads of flint and obsidian from Stonehenge and Mexico with splinters of flint produced in modern process of making gun flints. Collected by the Revd. Dr. Buckland. Nat. Size," and both were "lithographed from Nature by G. Scharf."

I am not aware that up to this time there has been produced any satisfactory evidence that the nineteen plates just described are a part of the thirty mentioned in Mr. Mac Enery's Prospectus. For anything that has appeared, they may be, as Professor Owen thought probable, "those designed to illustrate the . . . second volume of the *Reliquiæ Diluvianæ*."* Indeed, this hypothesis is greatly strengthened by Mr. Vivian's statement to the effect that the plates were executed at the expense of the late Dr. Buckland, and that the stones had become the property of his son, Mr. Frank Buckland. It cannot be necessary to remark that the two hypotheses are by no means incompatible,—the plates may have been intended to illustrate Dr. Buckland's *Reliquiæ Diluvianæ* and also Mr. Mac Enery's *Cavern Researches*. I can offer no new evidence on the former proposition, but I think the latter can be established.

When transcribing Mr. Mac Enery's Manuscript, especially those portions of it which treat of the Palæontology of the Cavern and have never been published, I met with numerous references to Plates which, like those just described, were defined with letters, not numerals. Further, the figures spoken

* See "History of British Fossil Mammals, and Birds," p. 166. 1846.; and "Trans. Devon. Association," vol. ii., p 509, note. 1868.

of as being in given plates were found to be actually there. In short, the plates Mr. Mac Enery designed to illustrate his "Cavern Researches" where either those which Mr. F. Buckland and Mr. Vivian rescued for Science, or they were precisely like them. I am sorry to add that the stones are now lost beyond hope of recovery.

It was my first intention to attempt no more than to give the substance of Mr. Vivian's compilation, or edition of "Cavern Researches;" but a consideration of the subject, in all its aspects and bearings, led me to the conclusion that to publish the entire manuscript would be a wiser course; for,

1st. Those portions of it which have never been printed contain much valuable information.

2nd. So long as the world is in possession of parts of it only, the feeling will remain that it would be benefited by having the whole.

3rd. By printing *in extenso*, the best opportunity will be given for forming an opinion respecting the extent and variety of the author's reading, his mental powers and acquirements, his prepossessions and besetments, and the influences by which he was surrounded.

4th. It seems desirable that the facts and opinions with which the Manuscript is fraught should be ensured against accident by the whole being put into the safe keeping of print.

From what has been stated, it is obvious that at least a large part of the Manuscript is not in the condition in which the author was likely to have sent it to the press; and it may be safely inferred that he would not have printed the whole of it, for, as Mr. Vivian remarked in his *Preface*, portions of it have been "rewritten several times with considerable alterations." Nevertheless, as these alterations are usually additions, I have decided to take no liberty of any kind with the author. He will be allowed to carry out his own views as to orthography, capitals, punctuation, and English composition generally; his abbreviations will be faithfully imitated, and his lacunæ filled with asterisks. In the very few cases in which missing letters or words will be supplied editorially they will be enclosed within brackets, as in the following example—"Dr. B." [uckland.] When a word is so obscurely written as to render it doubtful whether the right one has been written by the transcriber, it will be followed with a note of interrogation enclosed in a bracket, thus [?]. When a word, distinctly written, is obviously incorrect, it will nevertheless be printed, but will be followed by the presumably correct

word, to which a note of interrogation will be prefixed and the whole enclosed in a bracket, thus:—"and invariably is [? it] announces." When a word has obviously been omitted, it will be inserted in a bracket, as, for example:—"rock after [rock] discloses the same appearances." All editorial notes will be followed with the initials "W.P.," and enclosed in a bracket. In short, everything within brackets will be editorial; everything else will be by Mr. Mac Enery. When two words or phrases of the same general import are written, one *in* the line and the other *above* it, and both are left for further consideration, they will be enclosed in separate braces which will succeed one another, the first containing the words given *in* the line in the Manuscript, and the second, those *above* it, regard

thus:—"inclined us to consider them"—"inclined us to {consider} {regard} them."

The different fasciculi will be kept distinct, and will follow one another as the author intended, or, where this cannot be determined, in what appears to be their natural or most convenient order.

All "miscellaneous," or, so to speak, irrelevant notes or memoranda written on "blank" pages of the different fasciculi, will be relegated to the fasciculus J, or that of "Scraps, Notes, and Memoranda," the contents of which will be numbered and marshalled in orderly succession, commencing with two essays of a "Dedication," and ending with what the author terms a "Wind Up."

In order to facilitate reference to the original, figures in brackets will be printed on the margin of the pages, and will denote that the line opposite which such figure—say [5]—stands contains the commencement of the fifth page of the fasciculus in the original, and so on.

Whilst scrupulously abstaining from taking any liberty with the author, equal care has been exercised to secure from him the same treatment of the authors he quotes. So far as it has been in my power, I have verified his numerous citations, have prevented their being altered in any way, and have given full references to the original works.

[FASCICULUS A.]

ORIGIN OF CAVERN RESEARCHES.

[1]

RESEARCHES of this nature do not date far back in this country. Except as places of popular resort, caverns attracted little notice before their fossil contents were brought to light. Had this event occurred at an earlier period, they would doubtless have been regarded with the same feelings that those were, in which bones were first discovered in Germany. There they were generally reputed to be the sepulchres of fabled animals, half Bird, half [****], and styled after them the "Dragons' grottoes." As their relics were presumed to possess supernatural virtues, they were sought for charms and cures; and in course of time rose into such estimation as a sovereign specifick, that they finally took their station in the *materia medica* under the quality of the fossil Lycorn. Nothing more was wanting to make them an object of speculation, to supply the demands of which the mountains were ransacked for caverns and the caverns for bones, a circumstance to which may be traced the discovery of both one and the other over a large tract of the continent.

From the people, as happens in most cases, the subject passed into the hands of men of science. It now became important to ascertain if these mysterious relics were the remains of the animal to which popular belief assigned them. It is not hard to conceive how the multitude ever prone to the marvellous should have been led astray by their imagination: but that the learned should have persisted in attributing them to a chimæra, whose prototype it was gravely contended still existed in Transylvania, it is not quite so easy to comprehend.†

† A similar misapprehension prevailed with respect to the nature of the fossil bones discovered in the plains. From their occurring in the earth, the people of the north of Asia concluded that they had belonged to an animal which lived like the mole underground, and perished as soon as it saw the light. Thence it was called Mammoth or Earth-born.—

Even by the learned they were regarded in the middle ages as the remains of giants. It was at no very distant period they were assigned to the Elephant and Mastodon.—

Their tusks were wrought up for the same purposes as recent ivory, and the enamel of their tooth stained by the oxyde of copper passed as an article of commerce, for Turquoise.

Others saw a resemblance to the Hippopotamus, but it could only apply to its bulk.

In this position stood the controversy, when comparative anatomists interposed, with the immortal Cuvier at their head; and having first shown from the immutable laws observed by nature in the structure of her creatures (works) that such a monster could not have proceeded from her hands, and that it was purely a creation of the fancy of painters and poets, they transferred the disputed remains to an extinct species of Bear, essentially different from the modern in its form and size.—

- [2] The species of the Cavern animal being once determined, the transition was natural to the cause of its inhumation in such regions. And already had the speculative genius of naturalists on the continent been long exercised in search of a clue to the difficulty, when the disclosure of similar phenomena in the section of a rock in Yorkshire by some labourers employed in working a quarry, brought the subject under the consideration of British Geologists.

A leading member of one of the universities repaired to the spot, seized the facts as they revealed themselves, and speedily announced those results which profess to resolve the problem.

An appeal, however, having been naturally made, to a larger search for confirmation of these views, a fresh impulse was given to the labors of those engaged in this field of inquiry.

Both continents were accordingly explored for further evidence, and with such effect, that almost each new arrival brought home parcels of remains, collected from rivers, lakes, and superficial gravel, throwing light at least on that coordinate branch of the question (incorporated with the theory of caves) concerning the distribution of correlative animals, through the soil over the surface of the globe. Nor was illustration on the point immediately under consideration slow in following. The unexpected discovery of a living *Hyæna's* retreat in India, the threshold and floor of which was strewn over with the half-devoured carcasses of animals of the country, disclosed coincidences with the cavern of Kirkdale, such as the most sanguine could have scarcely dared to anticipate.

In the mean time excavations were carried on in the caverns, superficial and alluvial deposits of France and the Netherlands, affording results bearing on the question, and which shall be discussed in the sequel.

- [3] Nor were naturalists at home behind their brethren abroad in industry and skill. Each district was examined by men

qualified by habit and science, or by persons like myself impelled solely by a general interest in the research.

Thus was a spirit of enquiry widely propagated among all classes in the short space of a few years, during which it may be asserted that more light has been struck out on the condition of the earth than in the same number of centuries preceding it.

By the concurrent discoveries of comparative anatomists on the continent and geologists aided by chemists in this country, that rapid approach was made to a knowledge of the nature and revolutions, Physical constitution and history of the Globe, which advanced the private pursuit of a few naturalists to the rank of a science, second only to the sublimest of all in the grasp of its views and importance of its inductions.†

Northmore.

[7]

The cavernous nature of the Limestone on the coast of Devonshire did not fail to attract Geologists from a distance, whilst those living in its vicinity pressed forward to anticipate the researches of strangers and to bear away from them the palm of original discovery—

Kent's Cavern was too generally frequented from the earliest periods as an object of natural curiosity not to draw attention to it as most likely to afford organic remains. So far back as 1823–4, it had already been visited by the person most concerned in its disclosures, but the pressure of professional duties permitted him it appears little more than a cursory glance at its surface then—

In the mean time the ground was broken by individuals impatient to lift the veil from its depths, some of whom sought the elucidation of an important question involved in its history, while others avowedly looked there only for a color *to* pre-conceived theories respecting its conformation and contents.

Mr. Northmore, who had already traversed the county in pursuit of Druidical and Roman antiquities, is understood to be the first that {ascertained} {discovered} the existence of its fossil reliques. We refer to his own statement, it being best to let him relate in his own words his impressions respecting it. The reader will be thus enabled to judge of the degree of weight that should attach to this gentleman's specu-

† [The lower half of pages 3 and 4, and the whole of pages 5 and 6 are missing.—W. P.]

lations. (Vid note A.) (The inverted commas and Italics it shd be premised are all his own.)

NOTE A.—“For many years I have been employed in collecting materials for a more perfect *Theory of the Deluge*; but the work so grows on my hands, and the science of Geology is so rapidly increasing, and pervading so many other sciences, that I know not either when, or how, I shall be able to complete it: It is my misfortune to differ both from the Oxonian Professor and ‘the great teacher’ Cuvier, and several of the Scotch and German Geologists, upon their Diluvian and Antediluvian Theories, and particularly upon their ideas of the primitive ‘non existence of organic beings’ of ‘the late formation of man’ and what is termed the ‘order, or succession in the creation’ of animals.”

- [9] “In the month of September, 1824, I visited with my family, Torquay, without having the remotest idea of making any excavations in its caverns for the purpose of discovering their hidden treasures, but with the full and avowed design of examining *Kent's Hole* for a very different object; viz. to ascertain whether it were or were not a *Mithratic Cavern*; for the Druidical Priesthood like their Egyptian, Chaldean, and Brahminical brethren, worshipped in such cavernous recesses, (whether natural or artificial,) the Solar God, under a variety of names—such *Muidhar*, or *Mithras*, *Bel*, *Belinus*, *Beluerus*, *Belatucader*, the *Tyrian Hercules* and *Ogmios*, *Cocideus*, etc. while the Eastern titles of that Deity were more generally those of *Osiris*, *Orus*, *Thoth*, *Budha*, *Cresshna*, *Mahadeva*, or *Seeva*, and more than a hundred others. In several of these deep and gloomy caverns, or temples, (which mystically represented the Diluvial Abyss) and particularly in those of *Elephanta*, and *Ellora*, in Hindostan, the emblems of the *Deus Genitor* yet remain.”

Mr. Northmore resumes—“In these gloomy temples the Catechumens were initiated and ‘purged of their sins.’ Here they saw in representation ‘the torments of the damned, and the joys of the Blessed.’ Such were the Eleusinian orgies, and many were the scenes of peril and horror through which the Epoptæ passed. One of the most usual modes of Purification was by creeping through a hole or orifice or passage in the rocks, or by passing an arm, or leg, or portion of the body through it, if of small dimension; or by going through a door or gateway; but this could not be done by the Aspirant, without the aid and approbation of the Priest, the door of itself ‘violently opposing’ the wicked and impure, and ‘denying them admission’ to the sacred ‘fountain of pellucid water.’

- It was partly then with this view of investigation that I went to Torquay, A.D. 1824, and having, by mere accident, mentioned this my intention to my brother-in-law Capt. Welby, (there resident,) who had the beautiful work of Belzoni, upon the pyramids of Egypt, lying upon his table, he kindly offered it to my perusal, as thinking it might be of service to me in my Mithratic pursuit,—as in truth it really was; for the fact is that the Pyramids of Egypt [10] (as was the Tower of Babel) were built for the same object and mystery; the water of the sacred Nile was brought into them and used for the same purpose of baptismal regeneration, as the natural ‘pellucid water,’ of Castleton cave and Kent's Hole; and the rock-basins, and stone-bowls of the Nymphs and Druids; and the tanks and reservoirs of the Hindu Pagodas were designated to a similar end.”

(Mr. N. goes on to state that hitherto his scientific pursuits had been confined chiefly to Antiquities and to Chemistry, and after complaining of the jealousy of Sir Humphrey Davy, Mr. Faraday, Cuvier, Jamieson, &c, who suppressed his name as an original discoverer of Gases, Caverns &c, He again returns to the subject of the cavern.)

“It now occurred to me, that I might, as the saying is, kill two birds with one stone, and extract as many organic remains from our Devonian limestone caverns as the Professor had done in Kirkdale. With both those objects then in view, I hired two assistants (William Rossiter and John Ferris), and

Mr. Northmore was speedily followed by a gentleman well [13] known in the scientific world for his contributions to almost every department of knowledge. Though not the original discoverer, Mr. W. C. Trevelyan was certainly the first that obtained any results of value to science, of which he had an engraving executed on his return. It exhibited simple teeth of Rhinoceros Hyæna and Tiger with jaws of the Bear and Fox—and one or two inconsiderable bones.†

This it appears is all that was known of the cavern up to 1825; too little manifestly to satisfy the longing of the public for the fullest information. The existence of fossil bones, referrible to five species, was established, it is true;—but in what number, and in what state, and under what conditions, the great body of organic remains {occurred} {appeared}, these were enigmas that this handful of fossils was insufficient to resolve.

It is at this point that my labours commence, of which, though late, I propose to lay the narrative before the public.

accompanied by an able draughtsman, Mr. Gendall of Exeter, I set out on the 21st September, A.D. 1824, with the double object of discovering organic remains, and ascertaining the existence of a temple of Mithras; and happy am I to say that I was successful in both objects; in the former pursuit indeed I have been followed by hundreds, in the latter by none. The baptismal lake of '*pellucid water*' the creeping path of '*stone purification*,' and if I am not quite mistaken, (for I speak doubtfully) '*the mystic gate of obstacle*;' the '*overt mouth*;' and possibly one more *arcane memorial*, sufficiently satisfied my mind upon the Temple of the extensively worshipped, and thousand-named Deity, Belin. But upon this subject no more at present, and I proceed to the organic treasures of the sacred Arkæan Cave.

"Upon entering, then, the Cavern, and being at that time a novice in the [11] art of exploring, I began to consider in what part it was most likely to find the expected treasures, and seeing a small recess in the Cavern, of a size sufficiently capacious to hold a large tiger, I began to dig therein through the stalagmitic covering, and in less than ten minutes I could not forbear exclaiming with joy—*Here it is*; and I pulled out an old worn-down tusk of an *Hyæna*, and soon afterwards a metatarsal bone of the *Cavern Bear*. About 20 or 30 other teeth and bones were the result on that day; but among them, and what I much prized, were the jaws upper and lower, of either the Wolf or the Fox; these I placed, as I thought, safely in my basket, but upon my return to my lodgings I found they were gone," (a grave charge against W. Rossiter and John Ferris) "and though I subsequently offered a reward to the finder, I was never able to recover them. Such then were the fortunate results of the first day, and *my object was complete*; for in truth my views tended more to *Principles* than mere matters of fact, and experiment." (Panorama of Torquay.†)

† ["The Panorama of Torquay," By Octavian Blewitt. 2nd Ed., (1832) pp. 107–138. See also "Trans. Devon. Assoc. for Advancement of Sci., Lit. and Art," (1868) pp. 479–496. W.P.]

‡ [Copies of a Plate of "Teeth and Bones found in Kent's Hole, near Torquay, Devon, 1824, *M. Morland del et lithog. Printed by C. Hullmandel. London Pubd. by John Murray. Abemarle St. 1825.*", and answering in all respects to the author's description, have been recently presented to the Torquay Natural History Society, by Mr. Gardner of Torquay. W.P.]

I had hoped, and it was to be desired, that the subject would have been taken up in the interval by those best able to handle it; and it was in this expectation that I had long laid aside all intention of sending my notes to the press. Other and greater undertakings have retarded the execution of the design where I knew it was contemplated. There remains to me therefore no other alternative than to yield to the duty which my discoveries impose on me, towards science, by publishing an account of what I know of the cavern. I avail myself of the return of health accorded to me by a merciful Providence to record those researches, from which illness not improbably occasioned by them, has long compelled me to desist.

It being my desire to present a faithful picture of this extraordinary repository of the relics of every age, I pray the reader to transport himself to the scene and to follow me through its depths that he may be witness and judge of the facts that shall be exposed to his view. For this purpose it [14] will be necessary to enter into minute details from which a work dealing in general conclusions built upon previously ascertained facts is dispensed—Though at the close of our researches we {may} {should} give expression to the irresistible inferences at which we arrived, our aim is rather to supply matter to others than to speculate ourselves.

Thus much we thought it necessary to premise before entering upon our narrative.

[15] *Occasion and results of my first visit.*

To the following incident I am indebted for first directing my steps towards the Cavern:—

Having one morning in the summer of 1825 chanced to hear a friend (the late Captain Welby) express his intention to join an exploring party there, I was induced to accompany him. We found his relation Mr. Northmore, of whom mention has already been made, at its entrance, surrounded by about a dozen persons, among whom were remarked the Commander of the coastguard and his men. All busy in equipping themselves for their expedition underground.

The passage being too narrow to admit more than one person at a time (and that only in a stooping posture) the company entered in files, each bearing a light in one hand and a pickaxe in the other, headed by a guide, carrying a lantern before the chief of the band. I made the last of the train, for I could not divest myself of certain undefinable sensations, it being my first visit to a scene of this nature.

As soon as the party was assembled in the vestibule, Mr. Northmore ascended a rock, from which he delivered instructions to the group around him, respecting the plan to be pursued in their operations during the day. He next distributed the coastguard through the several chambers, and employed himself in passing to and fro, superintending their proceedings—Notwithstanding which there was little or nothing added on taht occasion to what was already known of the cavern—Indeed no individual with his single arm could do more than pierce the crust superficially, but instead of desulto. * * * * * had all hands been brought to bear on any particular point, they must have necessarily reached the bones, for there is no part where they may not be found below the stalagmite. After witnessing the complete failure of this expedition I have been since at a lost to explain Mr. Northmore's statement of his extraordinary discoveries on a pre- [17]vious occasion in less than "ten minutes."

The party was however somewhat consoled for their disappointment by the discovery in the black mould, of certain rudely shaped pieces of oak, one of which was immediately shown me by Mr. Braham, the finder. It was about the length and form of the human foot, and hollowed in the centre not unlike a sandal—I accordingly gave it the name which it has since borne of the "Druids sandal"—The designation though applied only in allusion to the lecture we had just heard, was too good not to be caught at and adopted, as it seemed to countenance certain fanciful doctrines then promulgated, with all the authority of an oracle, and since consigned to the article from which ample extracts have been given touching the conversion of the cavern by the Druids into a Mithratic Temple.

Perceiving that it was vain to look for the fossils, without first piercing through the crust which stood between them and the mould under foot, I betook myself alone, to a spot which had the {appearnce} {air} of having been disturbed. It was one of those perforations in the floor which further observation enabled us to trace to burrowing animals situated half way down the vestibule or Sloping chamber—in a cove on the right against the wall. The mouth was partially choked up with soil of which a heap was thrown up around its margin. It was slightly glazed over with the drop. The earth was of a reddish brown, unctuous to the touch and from the presence of a profusion of recent bones bore evident marks of frequent disturbance—

On tumbling it over, the lustre of the enamel soon betrayed

its contents. They were the first fossil teeth I had ever seen, and as I laid my hand on them, relics of extinct races and witnesses of an order of things which passed away with them, I shrank back involuntarily—Though not insensible to the excitement attending new discoveries, I am not ashamed [19] to own that in the presence of these remains I felt more of awe than joy—but whatever may have been impressions or the speculations that naturally rushed into my mind, this is not the place to indulge them—My present business is with facts.

I pursued my search in silence and kept my good fortune a secret fearing that amidst the press and avidity of the party to possess some fossil memorial of the day, my discoveries would be damaged or perhaps share the fate of those abstracted from Mr. Northmores basket—I was anxious to send them in the state they were found to Oxford.

In addition to specimens of the five species figured in Mr. W. C. Trevelyans plate there appeared several new ones belonging to Horse, Deer, Hare, Rabbit, entire head of Field rat, (campagnol) and a small feline or cat—with the bones of two species of Bird—But the most remarkable discovery of all was that of the upper jaw of a Hyæna, the bone of which was eaten away close to the roots of the teeth, and even the upper portions bore impressions of gnawing.

The whole was accompanied by bones belonging principally to the small quadrupeds, some of which were fractured at their extremities, as if by the bite of a Dog,—and their barrels loaded with mud—

Along with the above was sent a lump of the soil through which were disseminated small splinters of bone and teeth of the Campagnol—The whole was immediately drawn on stone in a superior style by the Lady that executed Mr. Trevelyan's plate.†

This may be regarded as the first gleam of light that was thrown on the condition of the contents of the cavern.

My communication was followed by an answer which urged me to follow up my good luck—(Here insert it)‡

[21] *General Geological View of the District of the Cavern.*

Before entering into further details of the proceedings, it is

† [Copies of a Plate of "Teeth and Bones found in Kent's Hole near Torquay, Devon, by the Revd. I. Mc Enery, in October 1825. *Drawn on Stone from Nature by M. Morland*," have been recently presented to the Torquay Natural History Society, by Messrs. Greenfield and Gardner, of Torquay. W.P.] ‡ [This letter does not accompany the MSS. W.P.]

fit the reader should be presented with a brief outline of the geology of the environs of the cavern.

Devonshire is traversed through its centre by the great Granite chain which rises in Cornwall and terminates in Dorsetshire? dividing the county, like its spine, into two nearly equal parts, North and South.—The latter we have to describe at present.

This district, the Tourist need not be told, is distinguished from the rest of England by those ridges and Tors, which diversify its surface, and impart to it much of its picturesque character.

Besides the granite which skirts it on the * * * * (and on the side of which, it may be observed, in passing, the Bovey Lignite reclines) the rocks are composed of the two principal {formations} {classes?}, viz. Limestone (attended by its conglomerate above and shale below) and old red-sandstone (accompanied by its siliceous suite) on which the Limestone reposes.

The Limestone ranges in an almost uninterrupted line from Petit-Tor to Devonport, embracing in its course, among other towns, St. Mary Church, Torquay, Totness and Ivy Bridge—

Until recently, it was always esteemed a member of the Transition series—Mr. De la Beche succeeded by a comparison of its organic remains, in establishing its identity with the Carboniferous species.† Another high authority, however, is disposed for the sake of simplicity to retain its ancient classification, considering it convenient to include within the Transition series all kinds of stratified rocks from the earliest slates, in which we find the first traces of animal and vegetable remains, to the termination of the Gt. Coal formation “The animal remains in the more ancient portion of this [23] series, viz. the Grauwacke group, being nearly allied in genera, and differing only in species, from those in its more recent portion, viz. the Carboniferous group” (Bridg. Tr. p. 60.)‡ It reposes on old red sandstone, or more strictly speaking, on beds of argillaceous shale interposed between it and the Sandstone, with which in some places it is seen to *inter-stratify*, and into which in others it seems to pass.

From Meadfoot where it reposes on the red sandstone to

† [*On the Geology of Tor and Babbacombe Bays, Devon.* By Henry Thomas De la Beche, Esq., F.G.S., F.R.S., F.L.S., &c. Trans. Geol. Soc. Lond. 2nd Series, vol. iii., Part 1, p. 163. Read 1827. W.P.]

‡ [*Geology and Mineralogy considered with reference to Natural Theology.* Being Sixth of the Bridgewater Treatises. By the Rev. W. Buckland, D.D., vol. i. p. 60. Note. 1836. W.P.]

Upton where it forms a zone round the shale; it thence stretches out in a tongue as far as Coffinswell.

At this point it disappears under the Exeter conglomerate—Emerging again at Kings Kerswell, it holds on its march to Newton. Thence it may be traced through the vallies of Bradley and Ogwell, successively to Ipplepen, Dartington and Totness on its road to Plymouth, where it rejoins the branch that followed the line of the coast and from which it was separated by the intervention of Schist?

Its laminae are of various density from a few inches to several feet. They attain great thickness in the quarries of Park Hill.

It is frequently intersected by calcareous veins, and abounds in Barytes. In texture it passes from compact to Crystalline, especially in the vicinity of Trap.

Its ordinary colour is a pearly grey—it occasionally assumes shades of deeper intensity—

The Semi crystalline variety at Petit-Tor broken into boulders of several tons weight and composing a massive species of conglomerate supplies those curiously tinted marbles, which nearly rival the Italian, and are worked up at St. Mary C[hurch] and Torquay for like purposes of art.

[25]

The Shale.

The shale with which the limestone alternates, in its upper members takes a reddish hue and a brownish grey in its lower. and, according to the authority of Mr. de la Beche whose views we follow in this sketch, is identical with the shale of Pembroke—†

Conglomerate.

The conglomerate which overlies it, is composed of fragments torn from the parent rock it overlies—

One of the most curious examples existing, is in the loose masses (of which we have spoken as furnishing ornamental marbles). at Petit Tor resting in the form of conglomerate on their native beds of Limestone—and which are thought to have been detached by the action of water.

Old red Sandstone.

We have lastly to speak of the old red sandstone on which the Limestone and shale rest—

† [Op. Cit., p. 164. W. P.]

It is, according to Mr. Conybeare,† a continuation of that siliceous group which stretches south from the vale of Taunton into Devonshire—Advancing along the vale of Crediton to Exeter, and thence to the coast in a southern and continuous direction, by Chudleigh and the Teign, it terminates at the S.W. angle of Torbay, between which and the Teign a branch runs in amongst the Limestone—as another bends its course in land through Chelston and Cokington, occasionally disappearing beneath the Exeter conglomerate.

Under the red siliceous grit of Meadfoot occurs a grey fissile and micaceous sandstone. It traverses the point of land called *Hope's Nose*, sustaining the Limestone—

This Grit rock is traversed by veins of Trap, like the Red grit of Meadfoot in contact with the Limestone of Kent's Hole—

Trap.

[27]

To the west of Babbacombe Trap pierces upwards through the argillaceous shale into the Limestone, the adjacent beds of which are fractured and contorted, and portions of them inclosed in the mass of Trap. The shale is elevated to the summit of the cliffs at Oddicombe.

The Sandstone strata, between Livermead and Cockington, are confusedly huddled together—the dip at all angles.

Such disturbance of the lower strata could not fail to be felt by the upper. Accordingly we find the Limestones and shales inclosed in the Trap—

No where except in the Alps have I seen paralleled the contortion in the strata which Mr. de la Beche at the time he was engaged in the examination of this district pointed out to my notice, {sections} {diagrams} of which he has since given in his works.‡

In the valley of Lauterbrunnen and on the left flank of the lake of Lucerne near Fluellen, may be seen *sections* on a grander scale, which remind one of the bent strata of this district—

Such is the confusion prevailing through the whole that there is no where to be obtained a regular dip. In one quarry near the Torquay Turnpike,§ the dip is at an angle of 35—

† ["Outlines of the Geology of England and Wales," by the Rev. W. D. Conybeare, F.R.S., M.G.S. &c., and William Phillips, F.L.S.M.G.S. &c., 1822, Part I, Book 2, chap. 4, pp. 290-1. Mr. Conybeare, however, is speaking not of the *Old*, but of the *New Red Sandstone*. W. P.]

‡ [See Geol. Trans. 2nd Series, vol. iii. Pl. 19. W.P.]

§ [This turnpike stood a little below the present Town Hall, Torquay. W.P.]

at another little further on the strata are vertical. On the new line through Stony Valley, the Limestone projects from the sides of the ridges in bold crags, or bends over at † [the entrance, by the roadside into natural arches—

[28] *Name—why called Kent.* Vid. Lysson—Polwhele—Stukely—

Kent was a popular designation—

Several places in the county so called—

Kentford (Vid Stukely)

Object of superstitious wonder—Traditions and marvels—but not so much so as the German caves, the bones of which were vended under the name of Fossil Licorne for medicinal purposes—and on account of their mysterious virtues and it was searching for them that probably led to the discovery of such quantities were described to be the remains of monster dragons, the congeners of which were supposed to be living in Transylvania

It was a favourite place of resort in all ages—

Its recent annals seem to be written on its walls as its ancient ones are preserved in its bosom—like medals in a tomb—documents in archives.

Inscriptions in all languages.

Some of which date back so far as * * * * *

Inscription of Hodges in 1688, certain words lying by the course of the calcareous drop overlaid—coated over—others illegible from the filling up of the letters by stalactite. Others altogether concealed under the calcareous crust which has formed over them, but which could be scaled off, if necessary.

[29]

Southern arm of the Bay.

The Southern arm of Torbay exhibits evidence of convulsion no less decisive than that of the North. From Berryhead to Saltern Cove the Limestone is blended together with the Trap, and its calcareous quality so modified in consequence that it almost refuses to effervesce with acids.

From this it is evident that the strata of the district have undergone two distinct revolutions—

1. from the action of water in the abrasion of the rocks, the debris of which are accumulated in the form of conglomerate on the parent beds.

2. from the agency of another and more tremendous power, viz. of Trap, in piercing through, bending and ultimately enclosing solid masses of Limestone and shale—an event

† [Part of the page torn off here. W.P.]

which Mr. de la Beche† connects with the elevation, by the same cause, of the chalk and oolitic formations on the continent. This Limestone may be justly called, from abounding with caverns, cave Limestone as the Jura formation has been designated for the same reason Höhlenkalk—There is a chain of caverns from Kent's Hole extending through Dean and Buck[fastleigh] to Plymouth.‡

It is strongly impregnated with iron, to which it is indebted [30] for the variety of its tints—

The coast is much rent at Anstys and Daddys Coves—and masses projected into the sea, others corroded into arches by the waves—appear along the coast of Babbicombe and Torbay—Carbonate of Lime and sulphate of Barytes in the veins—

For a fuller description of the formation of this district, which yields in interest to no other quarter of the Globe, and from which Mr. De la Beche has drawn examples, I must refer to works which treat expressly on the subject, viz De la Beche 3 v Geol|| where it will be seen that the Geological constitution of this region as justly merits a pre-eminent place in the annals of the structure of our globe, as does the cavern among the * * * * in its bowels.

Approach.

[31]

It is in the midst of this scene of disorder that the rock of Kent's Cavern rises, halfway between St. Mary Church and Torquay, from each of which places it is about a mile distant.

Those who may be desirous to view the district just sketched, preparatory to a visit to the cavern, should approach it from the St. Mary Church road, which sweeps down by Anstys cove showing the nature and condition of the strata on a sufficiently intelligible scale.—From the Roman camp on the Down, the eye may follow the outline of the coast, from the limit of the Limestone at Petit Tor to the junction of the sandstone with the chalk. On a clear day the Oolitic Island of Portland may also be descried—

The approach from Torquay is by a lane, near the turnpike,§ which terminates in a wooded alley, flanked on both sides by ridges of limestone—In that on the right is situated the Cavern. The ascent to it is gradual. The way lies over a stone gap, after which it winds up through tangled {wood}

† [Op. cit. p. 170.]

‡ [The lowest third of the page torn off here.—W. P.]

|| [The author no doubt alludes to the paper "On the Geology of Tor and Babbacombe Bays, Devon," referred to above.—W. P.]

§ [The turnpike here alluded to has long been removed.—W. P.]

{brushwood} in front of the mouths. Those who may have come by the St. Mary Church road are, from the display of the fissured coast and the outstanding rocks in the sea, prepared {for the scene} {to see evidence of similar violence} now disclosed before them.

The gray masses scattered down the side, or ready to drop from the brow, of the hill—its rugged and creviced surface, through which the copsewood strikes into the interior, the vaulted and cleft openings in its flank, its stratification partly vertical partly horizontal, are so many traces of the igneous revolution which, at a remote period, seems to have created the cavern for the reception of the deposits of another—connecting the primitive with the Historic period—the same that impressed its violence on this ridge in common with the rest of the strata around the theatre of its ravages—

Entrance—

[30]†

Two apertures {about half way up} {near the summit of} the hill give access to the Cavern—That on the right appears to have always been the favorite entrance. It is simply a cleft in the rock of the form of a wedge reversed, diminishing from its base upwards. It is about 7 ? ft. wide at the bottom—5 ? ft high. Before the removal of the mould to render the passage more accessible, the cleft was not more than four ft. high.

The mouth on the left is a shallow arch formed by a natural span of the strata, loose masses of which project out above, overhanging the entrance—In its present state it has no more than 3 ? feet of elevation, but in its natural condition before the soil was raised as a fence against cattle, it gave five and about 9 in breadth—when the stuff was cleared away we found the rocky floor polished—

On the inside the entrance rises rapidly, and spreads out into a bolder vault—

These mouths are about 46 ft. wide of each other—are nearly on a line and on the same side of the rock of the irregularity of whose beds their remarkable difference of form is a just type—

The mouths look * * * the general direction of the cave {is from * * *} {follows the ridge}

Length according to Northmore 657 feet.

Before the addition of the mud and elevation of the level of great capacity

Measurements of the ridge * * * of the Interior * * *

† [There is a duplicate "page 30." W.P.]

1 from the mouth to the end of the passage * * * cul de sac * * *

2 from the wall at the right of the passage to that at the extremity of the U. Gal [Upper Gallery] * * *

3 from the left mouth breadth across Sally ports * * *

4 from the left wall of the vestibule to the opposite wall * * *

5 from the extremity of the Wolfs cave to the termination of the arcade * * *

6 Breadth of the montagne russe * * * thence thro the oven * * *

7 From the Arcade to the Water * * *

8 Length of Oven * * * Measurement of Bears den * * * Substalagmitic regions * * * .

Floor covered with mould—

[32]

The floor we found at our first visit covered thro its whole extent with a darkish mould varying in depth from a few inches to a foot—It only dates since the cavern became a popular place of resort, and the further progress of the stalagmite in open situations was interrupted by the trampling of visitors. In the vestibule were found deep imbedded in it those curiously shaped pieces of oak to which the appellation of Druids sandal was given, as has been remarked—together with a quantity of decomposed animal and vegetable matter, the remains of fires and feasts mingled with rabbits bones—

In the crevices of the rock, and in the cavities occasioned by the overlapping of fallen masses, were concealed the skeletons of such animals as strayed or retired hither to die, such as Dog, Hare, rabbit, sheep &c. The remains of the Bat with its delicate framework spread out on the black mould were particularly noticed.†

Breaking through the Stalagmite

In giving an account of our excavations we shall follow the order pursued by the Guides, so that those who may have visited, or who may hereafter visit the cavern, may be enabled to follow us.

We shall commence then with the common entrance—thence follow the direct course of the upper Gallery—and its lateral branches or Sally ports—We shall then return on our

† [The three paragraphs next following occur on a supplementary unnumbered page, and are introduced here in accordance with a direction to that effect in the MS. W.P.]

steps as far as the Vestibule, or sloping chamber, and, without stopping there, advance by the arcade into the cave at its extremity—from which we shall turn on the left into the region of the Bears Den or of the "Water"—

We shall return thence by the Oven, retrace our steps by the Arcade, traverse once more the sloping chamber in our way to the Wolfs den, which forms its right branch, and finally terminate our labors in the grand Vestibule or Hyænas Den

- [32] But for greater precision and perspicuity, we shall take the chambers in the order they are visited in—To commence with the common entrance.—Here once for all we must solicit indulgence for entering into details apparently unimportant—In this cavern are found grouped together phenomena observed separately in others dispersed over divers countries. By closely examining the disclosures of this, a clue may be obtained to all. At the hazard of unnecessarily charging the thread of my narrative with seemingly frivolous particulars, I proceed to note down the characters presented by its general aspect, no less than its contents, before it was altered by those operations which have since left no part of it in its virgin state.

It is only on a just appreciation of all their circumstances that a true estimate can be founded of those facts which should serve as the basis of all reasoning on its nature and history.

- [34] The floor of the entrance, except that it had the appearance of being broken up, offered nothing remarkable to detain us;—we shall have occasion to return to it presently. Not so the lateral branch by which it communicates with the body of the cavern on the left. At this point so great was the obstruction from the accumulation of mould and a fallen ledge of rock lying across the way that those who visited it will not have forgotten their accomplishing the passage on all fours. These impediments have been partly removed. Under a similar ledge on the left, still standing, was found the usual sprinkling of modern bones—and in the mould beneath, which had acquired the consistence of hard clay were found fragments of pottery; calcined bones, charcoal and ashes—in the midst of all were dispersed arrow heads of flint and chert—The ashes furnished a large proportion of the mould—

In the same heap were discovered round slabs of roofing slate of a plate like form some crushed other entire, in diameter * * * *

The pottery is of the rudest description, made of a coarse

gritty earth, not turned on a lathe,—and sunbaked. On its internal margin it bears zig-zag indentations not unlike those represented in the urns found by S. C. H. [? Sir Colt Hoare] in the barrows of Wiltshire.

These fragments there seems no reason for doubting are the remains of cinerary urns which once contained the substances scattered around to which the slates served for covers.

At a short distance nearer the entrance were found in a continuation of the same mould articles of bones of three sorts, some, of an inch long and pointed at one end—or arrow heads—others about 3 inches long, rounded slender and likewise pointed—Conjecture was very busy as to their destination. They were thought by some to be bodkins, by others for confining the hair like those ornaments used by the women in Italy—lastly they were supposed, with more probability, to be a species of pin for fastening the skin in front which served savages for garment.

“The shaggy wolfish skin he wore
Pinned by a polished bone before.”
(Herbert)

As precisely similarly shaped bones may be seen in the British Museum tipping the spears of * * * * their use seems to be satisfactorily defined—

The third article does not seem quite so easy to explain— [36]
it is of a different shape, quite flat, broad at one end pointed at the other—the broad part retains the truncated form of a comb the teeth of which were broken off near the root—whether it was used as a comb or for making nets for fishing is not clear. There was only this solitary one found and two of the former—but several of the first, with a quantity of bone chips—all three bore marks of polish—

Nearer the mouth were collected a good number of shells of the Muscle, Limpet, Oyster, Curdshell ? with a palate of the Scarus—This as well as the nacre of oysters which was thickly disseminated through the mould served as they do at the present day among savages most probably for ornament.

The shell fish may have furnished bait for fishing as the bone article may have served for making nets for the same purpose—[The] presence of these rude articles renders it probable that they were collected here by the an^{te} aborigines who divided their time between the chase and fishing in the adjacent sea—

Close to the opposite wall in the same passage, buried in black mould I found a stone hatchet, or celt of Sienite—

length * * * —breadth * * *—the only one found in the cavern—Another of the same material but of a different shape I found shortly after not far from the cavern near Anstys cove, which labourers engaged in making the new cut had just thrown up with the mould—

- [38] As we advanced towards the 2d mouth on the same level were found tho sparingly pieces of pottery—the most remarkable product of this Gallery were round pieces of blue slate about an inch and half in diameter and a quarter thick. It may have served like the Kimmeridge coal for money—In the same quarter were likewise found several round pieces of sandstone grit, about the form and size of a dollar but thicker and rounded at the edge in the centre pierced with a hole by means of which they seem to have been strung together into beads—Clusters of small pipes or icicles of spar, such as depended from the roof at our first visit we saw collected here in heaps buried in the mud—similar collections we had occasion to observe accompanied by charcoal, throughout the entire range of the cavern—sometimes in pits excavated in the stalagmite

Copper Ore,—with these curious articles in the same stuff was picked up a lump of copper ore much oxydized which the late Mr. P [hilips] analyzed and found to be pure virgin O [re]. Though this branch of the cavern is more spacious and the mouth more ample, it by no means furnished an equal proportion of antiquities as the other.

Several of these articles were slightly encrusted with a pellicle of stalactite according as they happened to lie within the reach of the drop when exposed on the surface—

[40]

(Boar Spear).

About half way between the two mouths on the right side of the Upper Gallery, beneath a large mass that formed a species of grotto, the roof and floor of which were joined with spar, the space about 3ft high and 6 square—were found lying together the following articles—An iron spear-head, a tusk and 2 portions of the jaw of a Boar—the Head of a Badger and the phalanges of a Hog—all these objects are incrustated precisely like articles from the Dropping springs of Derbyshire and Germany, from which they can be distinguished only by the reddish tint of the spar. They were not imbedded in the floor but slightly attached to it by the cement. Some shells similarly encrusted.

There was no mould on the floor of stalagmite—no indication of the visits of man since these articles were deposited

The spearhead is long—the haft was filled with Spar—
(Vid Plate)†

The relics of the Boar are the more remarkable none having been found in the same deposit with the great mass of bones—but simply encased in stalactite as here, or deeply imbedded in the stalagmite floor in the vestibule of which hereafter—

Having taken a general survey of the surface of the floor, we returned to the point from which we set out—viz the common passage—for the purpose of piercing into the materials below the mould—Here on sinking a foot into the soil, (for of stalagmite there remained only the broken edges adhering to the sides of the passage and which appeared to be repeated at intervals,) we came upon flints in all forms,—confusedly disseminated through the earth and intermixed with fossil and human bones, the whole slightly agglutinated together by calcareous matter derived from the roof.

My collection possesses an example of this aggregation in a mass consisting of pebbles, clay, and bone in the midst of which is imbedded a fine blade of flint, all united together by sparry cement.

The flints were in all conditions from the rounded pebble [42] as it came out of the chalk, to the instruments fabricated from them and fig in — Plate T†—representing arrow and spearheads and hatchets.

Some of the flint blocks were chipped only on one side, such as had probably furnished the axes fig.†—others had been on several faces corresponding exactly to the long blades fig† found by their side (and fig. * * * *) and from which they had evidently been sliced off—other pebbles were still more angular, chipped at all points, which were no doubt those which yielded the small arrow-heads which abounded in by far greatest number—Small irregular splinters not referrible to any of the above divisions, and which seem to have been struck off in the operation of detaching the latter, not unlike the small chips in a sculptors shop were thickly scattered thro the stuff—indicating that this spot was the workshop where the savage prepared his weapons of the chase, taking advantage of its cover and the light—

The arrowheads cut in triangular form, two lateral sloping planes between a central one more elevated—the two lateral

† [I have not been able to obtain any information respecting this plate. W.P.]

† [Pl. T, "Cavern Researches," contains 13 figures of "Knives, Arrow Heads and Hatchets of flint and chert found in Kent's Hole, Torquay, by the Revd. J. Mc. Enery." W. P.]

were sliced off the centre. Institute a comparison with those found in Mexico and Barrows†—As the pottery agrees with the urns so do the flint articles correspond with those found in them.

I have discovered in this passage precisely similar arrow-heads to those which I detected in an urn from a Barrow presented to me by the Revd. M Welland.

- [44] With the exception of the Boarspear and a blade of the same metal found not far from too much rusted * * * all the articles found in the mould or in the disturbed soil consisted of flint chert sienite and bone—such primitive substances as have been in all countries in all ages down to the present used by the savage for the fabrication of his weapons whether for the chase or battle.

At a still greater depth near the common entrance, lengthwise in the ordinary position of burial, in the passage lay extended the remains of a human skeleton—much decayed—two portions only of the jaw and some single teeth, with the moulding vertebræ and ribs were all that remained. As in the case of the flint knife-mass already described, there adhered to the jaw portions of the soil on which it lay and of the stalagmite which partly covered it—

The teeth were so worn down that the flat crowns of the incisors might be mistaken for molars—indicating the advanced age of the Individual. M. Cuvier, to whom I submitted the fragment in 1831 was struck with the form of the jaw.—He pronounced it to belong to the Caucasian race. He promised to bestow particular notice on it—but death, unhappily for science put a stop to his glorious labours—All the specimens together with a collection of fossil bones—the third I had presented to the museum of the Jardin des Plantes, I transmitted to him before I quitted the continent—and may be found among his effects. The skeleton lay about a foot and a half below the surface—from the tumbled state of the earth, the admixture of flags of stalagmite, added to the presence of flint articles and pieces of slate, it was manifest that the floor had been dug up for the reception of the body and that it was again covered over with the materials thrown up from the excavation—The earthy covering consisted of the red soil containing fossil bones mixed up with recent mould—the mound of earth outside the mouth at the right hand was thrown up from the passage to render it more

† [See "Plate U. Lithographed from nature by G. Scharf, Printed by C. Hullmandell," and recently presented to the Torquay Natural History Society, by Mr. Gardener. W.P.]

accessible—It was precisely it which covered the H. [uman] [46] skeleton and contained the admixture of Human and fossil relics—

Previous to the disturbance of the floor for the admission of the body, it would appear from the presence of flags of stalagmite in the rubble that it was covered with a continuous crust—the edges indeed of which still cleave to the sides—It further appears from the repetition of similar crusts as indicated by the broken edges at the sides that there were periods of repose which allowed new floors to form, marking clearly its repeated destruction and renovation at intervals of time—

With the exception of single teeth and an occasional rib or vertebra in the charcoal, which may have possibly belonged to the same subject, there were no other traces of Human remains. (Vid H. Vertæ Pl—)†

Human Bones

[48]

The learned have been long occupied with the question, whether the remains of men exist in a fossil state—

The question has been resolved in the affirmative by anct. observers who mistook the remains of animals for Human—And amongst the moderns those who admit the existence of fossil H. bones are in error respecting the application of the term fossil to them. M. Cuvier has shown that the group of bones brought by Spallanzani from the Island of Cerigo belonged to whales, and that the "*Homo diluvii testis*" of Schreuchzer was only a {proteus} {chameleon} of large size and of an unknown species. He has equally shown that the bones and works of art discovered at Canstadt were collected without any regard to their Geological position, and consequently no certain conclusion could be thence drawn—Cuvier seems to think that the real bones of man, gathered from different parts of the globe were the remains of bodies that had fallen into the clefts and fissures or interred in anct. galleries and covered with incrustations—and that it was the same with objects of human art—found with them.‡

Thus according to him the remains of our kind do not appear in the same beds with the fossil; a point at which we arrive equally if we observe that life has gone on on the globe proceeding from the simplest forms to the complex, and

† [Fig. 7, Pl. S, "Cavern Researches," is that of a Human Vertebra, and is probably that here referred to.—W. P.]

‡ [See "Essay on the Theory of the Earth." Translated from the French of M. Cuvier, by Robert Kerr, F.R.S., &c. (1813) p. 128-9.—W. P.]

that the fossils stopping at the quadrupeds, there was reason to presume that the Human species had not at least *all* perished with the animals which we discover in a fossil state on the continents which have {risen} {sprung} out of the bosom of the waters—

We all know the history of the Guadaloupe skeleton—the bones preserve their gelatine and phosphate of lime—their stony matrix consists of a calcareous rock formed of millerite intermixed with shells and madrepores, which shows that the remains are not enveloped by an anct. and regularly stratified rock—but simply by a local and modern incrustation—What we know of their position gives to this opinion the air of probability for these skeletons are in a considerable number, they are only partially encased in the madrepor [which forms their] † envelope, at a level too so inconsiderable above the beach [as to be covered] † in high tides.

- [49] This discovery does not prove, it is clear, the existence of Human bones in regular strata—we do not regard as such stalactites or Tufas which are constantly forming by the deposits of certain springs or infiltrations and which are found to envelope occasionally the H. bones—as is the case with those found in the grotto of Durfort,—of which by and by—

Since the discovery of Guadaloupe M. Schlotheim has announced the discovery of H. remains in ancient Gypsum in crevices and cavities which traverse it in all directions and the clay which fill them—in nests—in company with the bones of Deer, sheep and chevreuil, squirrel, Landmice, Bat and mole—Bird—M. Schlotheim admits that the facts require further investigation and whether the bones may not have proceeded from addition of bones at different epochs—

M. d' Hombres does not entertain the same doubt respecting the H. bones discovered in a cavern in the neighbourhood of Durfort, or Grotto of the Dead, department of Gard,—He at once designates them fossil—

M. Marcel de Serres visited this Grotto in 1818 and collected a large quantity of H. bones—but was far from considering them fossil from their position, and several other distinguished savans were of the same opinion—from the slight alteration in these bones, the manner in which they were found heaped together without any order, the modern stalactites which encrusted them, determined them to the conclusion that they were brought to this subterranean

† [Part of the leaf torn off here.—W. P.]

cemetery as were the bones of churches into the catacombs or quarries of Paris.

Discovery of a human skeleton in breccia from the Island of Samos, with shells—

(Quotation) (*Vid Geognose of Marcel de Serres*) [50]

No memorial as in the coins and swordhaft found in Anstis Cove of the Visits of the Romans to Kents Hole.

Buckland—

Human Bones

Vid Bucklands resumé in reference to the discovery of Human bones in Diluvium in Bridgewater Treatise—I cannot sum up better than with his remarks—104

“The occasional discovery of human bones and works of art in any stratum, within a few feet of the surface, affords no certain evidence of such remains being coeval with the matrix in which they are deposited. The universal practice of interring the dead, and frequent custom of placing various instruments and utensils in the ground with them, offer a ready explanation of the presence of the bones of men in situations accessible for the purposes of burial.”†

Again—“Frequent discoveries have been made of human bones, and rude works of art, in natural caverns, sometimes inclosed in stalactite, at other times in beds of earthy materials, which are interspersed with bones of extinct species of quadrupeds. These cases may likewise be explained by the common practice of mankind in all ages, to bury their dead in such convenient repositories. The accidental circumstance that many caverns contained the bones of extinct species of other animals, dispersed through the same soil in which human bodies may at any subsequent period have been buried, affords no proof of the time when the remains of men were introduced.”

“Many of these caverns have been inhabited by savage tribes, who, for convenience of occupation, have repeatedly disturbed portions of soil in which their predecessors may have been buried. Such disturbances will explain the occasional admixture of fragments of human skeletons, and the bones of modern quadrupeds, with those of extinct species, introduced at more early periods, and by natural causes.”

“Several accounts have been published within the last few years of human remains discovered in the caverns of France,

† [Bridgewater Treatise, vol i. p. 104. W.P.]

and the province of Liege, which are described as being of the same antiquity as the bones of Hyænas, and other extinct quadrupeds, that accompany them. Most of these may probably admit of explanation by reference to the causes just enumerated. In the case of caverns which form the channels of subterranean rivers, or which are subject to occasional inundations, another cause of the admixture of human bones, with the remains of animals of more ancient date, may be found in the movements occasioned by running water."†

- [51] If we take the point at which this stalagma was interrupted by the presence of Hog and charcoal for the period of the first visit of man to the cave, it will date about half way down from its forming after the inroad of the mud—

Mr. Lavoillard has shewn me Human skeleton from the Island of Samos—associated with pebbles and shells of several kinds—all mixed up together and consolidated into a mass—

At first sight it is easy to see that the bones do not differ from the condition of grave bones and that the matrix is only rubble hardened and agglutinated together—

I am persuaded that if due attention is paid to the place in which these remains occur—and the manner that they are intermingled with the soil and bones reputed fossil, it will be in every case found as from a display of similar phenomena in this cavern, that they are not coeval neither with one or the other but that they had been added subsequently to the deposition of the former and commingled with them into a common heap by causes such as operated here I mean the visits of man, or according to their position by the disturbing action of running waters—

Had I not devoted so long a period to personal examination of all the circumstances attending this delicate question, in common with others I should have fallen into the error of supposing human remains to be contemporaneous because conjoined with the deposit of mud and bones—

Into this opinion I fell at first from the discovery of flint blades in contact with both in several parts of the cavern and the alternation of the stalagmite and I communicated my impressions to Dr. Buckland with all the earnestness of sincere conviction—It was to this doubt chiefly is owing the original delay occasioned in the publication of my labours—It is only from extended observation over the entire field of the cavern that I have come to the conclusion that human bones are long posterior to the sediment containing pebbles

† {Bridg. Treatise, vol. i., pp. 105-6. W.P.]

and bones and that they date no more than half way down from that period—

There is no reason why Human bones should not be discovered with those of animals if man occupied the same countries with them—There is nothing in their composition to render them more perishable—if human bones had been buried by the mud which envelopes those of animals there was more probability of finding them preserved from the favorable circumstances than those which at a great distance from that epoch were consigned to the loose earth at the entrance—

The very circumstance of the diffusion of larger animals and Beasts of prey over the surface may have made man collect into communities for his self-defence and protection; and at best his numbers could bear but a small proportion to the races of animals which thickly peopled the forests and plains.

As he was not likely to associate with them it is in vain to look for his remains among theirs—but it is not at all impossible that his remains may be yet found collected together where whole communities perished by the same catastrophe that overwhelmed the races Elept. Rhin. the Hy. Tiger and Bear—

If ever a temptation offered for passing the H. skeleton for a *Homo diluvii testis* it is here, when accompanied by his weapons he is found mixed up in the Diluvium with the bones of the Elept. &c., but a regard to truth compels us to declare that all the attendant circumstances concur to the conclusion that his bones were deposited here by human hands at a period long posterior to the introduction of even the muddy sediment into the cavern—

Esper found in a remote chamber of Gailenreuth portions of a Human skeleton as also did Rosenmuller†—those found by the latter were clearly deposited there by the hands of man at no remote period as is evident from the regular order of the interment.

Those of Guadaloupe were also not very anct. from the modern quality of the milleporite. The same may be said of a H. skeleton now in the Jardin des plantes in a species of breccia composed of modern mould and shells—It can never claim the antiquity of that one of a Greek lady preserved in the Gallery of anatomy in the Jardin des plantes the traces of whose clasps and bracelets and earrings remain.

M. Schmerling in his turn claims remote antiquity for his H. remains found in the cavern of Engis, Liège, and carries it

† [See Dr. Buckland's "*Reliquiæ Diluvianæ*," 1823, p. 101. W.P].

as far back as the epoch of the fossil animals, Elep. R. and Bear.

"C' est à un mètre et demi de profondeur que nous rencontrâmes ce crâne, caché sous une brèche osseuse, composée de restes de petits animaux, et contenant une dent de rhinocéros, et quelques-unes de cheval et de ruminans.

La terre, qui contenait ce crâne humain, n' indiquait aucun dérangement; des dents de rhinocéros, de cheval, d' hyène et d' ours l' entouraient de toute part.

En effet, le peu d' élévation du frontal, son étroitesse et la forme des orbites, le rapprochent plus de crâne de l' Ethiopien que de celui de l' Européen,"† from which he concludes that it belonged to a man whose intellectual powers were little developed and consequently proceeding from an individual not in an advanced state of civilization—

Another skull belonging to a young person was found at the bottom of the same cavern alongside the tooth of an Elept. It was entire when first discovered but fell to pieces in the attempt to remove it.

The same phenomenon he remarked at Engihoul * * * * * covered but partially with stalagmite—belonged to men above 5 ft and a half French measure.

Mr Lyte found several heads in Ash hole at great depth, supposed to have belonged to R. Garr [Roman Garrison]

There is no reason why man who is allowed to have lived before the last catastrophe that destroyed animal life on the globe should not find his analogue among the existing H. race as well as the animals which lived in his time find theirs in ours.

What Cuvier said of Kirkdale applies to this cavern "Si les hyènes de Kirkdale n'ont point accumulé d'ossemens humains avec ceux de tant d'herbivores dont leur caverne est remplie c'est qu'elles ne trouvaient point d'hommes dans leur voisinage, ni en vie, ni morts et l'on peut considérer ce fait comme une preuve de plus que notre espèce n'habitoit pas avec les animaux que je reproduis aujourd'hui à la lumière."†

According to General Ernouf the consolidated sand which

† [Recherches sur les Ossemens Fossiles Découverts dans les Cavernes de la Province de Liège; par le Docteur P.—O. Schmerling. Liège, 1833, pp. 60—61. W.P.]

† [Recherches sur les Ossemens Fossiles, Par M. Le Bon G. Cuvier, Nouvelle Edition (1823). Tom. iv. p. 395. W.P.]

contains the human bones [at Guadeloupe] holds “also shells of species now inhabiting the adjacent seas and land, together with fragments of pottery, arrows, and hatchets of stone.” (Buckland)†

Stalactite and Stalagmite

[54]

As we advanced towards the end of the passage we found a floor of stalagmite—It may be expected by a portion of our readers that we should say something of its manner of forming—

The concretions of caverns and fissures are derived from the solution of the softer portions of the limestone by the action of water impregnated with carbonic acid—the substance so formed is designated Stalactite as it may happen to be appended to the roof, and stalagmite when attached to the floor—Its manner of forming is by the percolation of water thro the rents or pores of the rock which, as soon as it comes in contact with the air, disengages the acid, and allows the calcareous matter collected in its passage and which it held in solution to crystallize—The sediment thus precipitated assumes an infinity of forms and names, such as lustres and chandeliers, cascades and fountains, altars, fonts and pyramids—

This cavern, though in sparry concretions it may be surpassed by others in the county, is not destitute of the usual complement of these natural ornaments—the effect of which when the cavern is illuminated is much enhanced by the reddish tinge (communicated to them by the feruginous veins through which the drop filtered in its progress through the rock) which curiously streaks the alabaster surface of the sides, giving them the air of being hung with tapestry.

Tho unwilling to dwell longer on this subject, we shall not be pardoned if we pass unnoticed the stalactites in the upper gallery and vestibule. Immediately under the massive drops or “chandeliers” in the latter Hall stood corresponding cones on the floor, both were occasionally united by slender columns—tubes thro which the calcareous matter flowed downwards which had the [appearance]‡ of supporting the vault. [56]

In the upper gallery the fluid formed at the roof clusters of concre[tion]s,† at regular intervals like the pendants of a Gothic skreen and connected together by a transparent [cur]tain of stalactite.

It is not, however for their picturesque forms that these

† [Bridg. Treat. vol. i. p. 104, Note. W.P.]

‡ [Part of the leaf torn off here. W.P.]

concretions merit notice, but for the service they have rendered in sealing down the floor hermetically, and preserving its deposits sacred through long periods of time from disturbance and decay. It is therefore the deposit on the floor that should engage our attention—It has been thus formed—

The infiltration after dropping on the point of its respective cone and insensibly augmenting it with its sediment flowed down the sides of the mound and spreading round its base formed zone after zone “like circles in the water” until in its progress it was met by the concentric rings of adjacent cones, similarly forming and advancing. In this way was the whole surrounding space gradually invaded and covered with a continuous sheet of stalagmite, consisting of a multitude of concentric circles, the borders of which thinned away {*in proportion to their distance*} {as they receded} from their centre or nucleus which was often as many feet thick as their skirts were only inches. It was thus the crust was formed in the retired parts of the cavern, such as the Bears den and in the cave of inscriptions and the wolfs passage—

The block in the cave of Inscriptions bearing the superscription of 1688 is not a bad example—and in the excavated blocks in the same chamber, strewn about, may be observed aggregations of these rings as described—

In other parts as near the common entrance the calcareous moisture entered laterally through the clefts and crevices, and spread slowly over the floor—Its section exhibits alternate layers of red and white marking successive periods of rain and fair weather—

- [57] In the vestibule the lateral infiltrations accumulated against the sides [in]† the form of cascades—or following the inequalities of the inclined plane encrusted them—giving the floor of the sloping chamber that undu[ating]† surface which is compared by the guide to the “frozen sea.”

In other places the drop from the roof acted concurrently w[ith]† the oozings from the sides in forming the floor which consequ[ently]† partakes of both manners

According to the variation in the chemical fluids at different points of the work, this substance was deposited in crystalline beds, or granular, spongy masses—

Inverted pinnacles and needles—fantastic groups—formed of congregated drops of intermingled combinations—often presents a stratified appearance disposed in parallel lines—Invest the sides and surface with successive lenticular coats—ribbon like—filaments of calcareous spar, veins traverse

† [Part of the leaf torn off here. W.P.]

Common passage and the Chamber at its end—or Vomitory. [58]

In detailing the circumstances attending the discovery of the human skeleton we have described the condition of the passage—

The floor in the chamber in which it terminates partakes of the disturbance we had to remark at its commencement, with this difference that the stalagmite in the passage was pierced through for the inhumation of a H. body—here it was left intact, but covered with mould at stages of its formation which it subsequently encrusted over when the cavern was deserted and the drop was allowed to resume its process of incrustation—

The floor in consequence presents the anomaly of repeated parallel floors, the upper of which less pure and more discoloured than the inferior? between which rubble was interposed containing flint blades—Schmerling discovered two floors in the cavern of Chokier, beneath each of which were fossil bones†—These crusts were by no means continuous and occur only where extraneous matter was introduced on the occasion of the visits of savages to the cavern—or of the passage of animals which made it their thoroughfare. The fossil bones at this part differed in their degree of preservation from those in the rest of the cavern, feeling lighter being much discolored and mouldering as if from long exposure—my collection exhibits several instances—

They differ little from the remains that happened to project from the sides of the “tunnels” or which lay uncovered with stalagmite in certain situations, the bones of which were a dirty brown and the teeth turning to green—

Nor is the Diluvium of that clear red colour that it is elsewhere—it is of a dirty red, smells offensively as if from the decomposition of animal matter—black patches of decayed substances abound through it—Here in the body of the soil beneath the stalagmite were the roots of trees which had penetrated through the interstices of the rocky crust into the interior of the cavern—

In many respects there are points of resemblance between this small chamber and the Bears den, the only two places where there appear repeated floors of stalagmite (remark— If attributable not to local causes but to a second irruption, it would be general.)

From this chamber shoot off to the right two oven-like [60] recesses in the side of the rock, terminating in a cul de sac,

† [Op. cit. Chapitre ii. Section Première, pp. 24–29. W.P.]

but which, there is little doubt before the growth of the incrustations opened externally—they are long, broad and high—the floor is covered with an accumulation of soft mould of several feet deep containing only recent bones and fibres of trees which had struck in their roots through the crevices of the cave, many of them of the thickness of the wrist—A third shoot facing the mouth, is elevated above the ground and once conducted into a lower range of caverns of which we shall have occasion to speak under the title of the “Cave of Rodentia”—when working below we communicated with the person above by means of this arm. It is floored with stalagmite—

Upper Gallery.

We shall now proceed by the “passage of urns” (such for distinction sake we may call it) into the upper Gallery. It is formed of a succession of open vaulted chambers, unfolding progressively into each other, preserving nearly the same elevation breadth and level, with a downward tendency towards the end where it is closed by the rock so curiously encrusted as to receive from Mr. Northmore the appellation of the “Altar of Sacrifice” about the middle it is dimly lighted by the “vaulted mouth” which opens into it—with which it runs parallel

The floor of this gallery is so encumbered with fallen masses some of them several tons in weight that except in vacant spaces between them it is difficult to reach the bottom. Many of these ledges are impacted in the stalagmite or having fallen slantwise intercepted and accumulated the calcareous dropping on their surfaces, leaving the soil beneath unencrusted—

After various attempts we succeeded in opening an excavation about half way down this branch below the mouth—

Owing to the cause just stated we found the floor very irregular—consisting of masses imbedded in the stalagmite or of an aggregation of loose stones cemented together by the same substance. In this breccia were found articles of flint [62] and in one instance a fragment of pottery—but what struck us as most singular was a layer of reddish mud which overspread the stalagmite in this part—our surprise was still greater when in searching for pottery and the other articles already mentioned as occurring here, we fell in with fossil teeth in it—we were at a loss to divine its source when in proceeding with our operations below the stalagmite the mystery cleared up—We found to our amazement that the

entire region beneath was traversed in all direction by sewerlike tunnels sufficiently large and extensive to permit a man to range in a creeping posture {through} {over} the bottom of the cavern—

A regular system of subterranean passages was excavated in the soil, the main trunk of which runs conformably to the length of the gallery throwing off numerous branches to the right and left—I have penetrated several times more than fifty ft. up the main arm, much incommoded of course by the crumbling of earth from the roof—occasionally jammed up too by the projection of rocks from its sides or straitened by the contraction of the passage—on one occasion the soil yielded under me several ft. and I sank down with it to the great horror of my companions behind me in the passage, who expected to be ingulphed at the same time. The earth escaped into a vertical cavity in the floor of which we subsequently {availed} {profited} ourselves for discharging the excavated soil. I was nothing daunted however and renewed my attempt to come out at the opposite side of the cave in which it seemed to open in the hope of thus discovering a new inlet for the mud—I had only gone about a hundred paces when owing it is to be feared to foul air my light was extinguished and I was deprived of my senses—my friends supposed me lost and despaired of drawing me out—I was however extricated by my faithful fellow labourer Walsh, to whom I am indebted for my life—I suffered for some weeks [63] from the consequence of imprudence and it was some time before I was able to revisit the cavern. Since the passage have been ventilated the same danger may not exist at present.

Tunnels.

The spectacle presented by these {tunnels} {perforations} for such they are on a small scale was almost worth the risk—Scattered along the floor lay the recent jaws of Sheep, Deer &c. intermixed with fossil while projecting from the floor and sides appeared the remains of some twenty species of fossil quadrupeds—

The roof too exhibited the appearance of being studded with teeth and jaws which occasionally protruded forwards. The effect was still more striking when the soil become dry and mouldering from exposure parted from the fossils leaving them quite bare hanging to the ceiling—

The remains thus exposed to the action of the air were decayed and discoloured, the enamel of the teeth showed it most by their greenish streaks—

It was in the tunnels were discovered the entire under jaw or lip of the Hy.—the perfect jaw of a young animal of the same species. (Plate * * *)†

It was remarked that though a large proportion of the bones were broken and gnawed, it was certainly less than in the central chamber.

Except so far as the air had acted on the bones and soil by hastening the decomposition of the former and reducing to powder the mineral substances contained in the latter (become more perishable from long residence in the earth) there was nothing further to delay our attention in this gallery—

The reader will have anticipated me in referring the loose marl on the upper surface to these tunnels—It was thrown up by the animals which burroughed thro the subterranean soil—They took advantage of the uncovered parts which were skreened from the drop by the overlapping of fallen masses—to penetrate thro it into the body of the cavern from their excavation below—It will also be conjectured that it was from a similar source the earth was thrown up which furnished my [65] first discoveries near the other mouth and which were the occasion of my undertaking the examination of the cavern.

Before we quit this division of the cave we must notice the

Sallyports.

They were so called from their resemblance to such covered outlets in forts. They pierce the side of the rock of the upper gallery below the vaulted mouth—and tho it has not yet been ascertained if they open in the flank thro the side of the hill, there is strong {reason to believe} {presumption that} they do—They are vaulted at their entrance—height * * * * and run in a descending line to * * * * *

Their surface is covered for many feet, like the offshoots near the other entrance, with an accumulation of soft mould, but here it is mixed up with red marl and contains fossils confounded promiscuously with recent bones.

They are so honeycombed by the operations of the burroughing animals that the earth yields to the slightest pressure—It went down so far with one of our party that he called out for help fearing that he was going to be swallowed up with the earth into the abyss into which it was escaping—Certainly on one occasion we heard heavy masses followed by earth roll down into lower gulphs, of the existence of which there is evidence in the lower divisions of the cave—Our

† [Probably fig. 9, Pl. M, "Cavern Researches." W.P.]

party was so frightened by the incident that some more adventurous than the rest were compelled to yield to their instances and not to push his researches in quest of other entrances in this direction—It seems most probable that it was through these that the burroughing animals penetrated from the outside into the body of the Diluvium—The mould along their whole length abounds with the scales of Beetles supposed to be the faecal deposits of the Fox—from the [67] presence of which and other indications such as scratches on the newly tumbled earth—there is reason to believe that it was this animal which made the perforations in the floor—The base of the hill has been long known as a cover for foxes—Sir H. Carew has often earthed them here—and more than once we have heard them as if in the act of escaping as we pursued our excavation—

These offshoots have been at all times the thoroughfare of burroughing animals so as to prevent the stalagmite forming in a continuous sheet, notwithstanding the abundance of calcareous matter at the sides.

So constant has been the disturbance of the floor notwithstanding the copious {distillation} {infiltration} of calcareous matter by the roof and sides it was never allowed to attain any consistency—

Arcade.

[69]

We have now to retrace our steps and proceed down the sloping chamber, from which we shall turn off on the left into the arcade or corrydor which conducts into the cave of Inscriptions and the Bears grotto—The floor of the corrydor was in great disorder—strown with rocks the spaces between which were formed into natural reservoirs of water—The arcade goes on progressively diminishing until it opens into the cave of Ins[criptions]. About half way up, the passage lies over steps cut in the stalagmite—and the floor maintains the same level through for the rest of the way until it opens into the spacious hall at its termination which from the number and antiquity of the Inscriptions deserves to be distinguished accordingly. (Give the Inss. in a note) but the floor at the entrance of the arcade is an exception to the disorder—It is free from adventitious substances having been protected by the projection of the left wing of the vestibule from their admixture during the formation of the stalag. It is a spongy tufa not deposited like the rest in alternate layers of various depth and tint—but simply a pure white homogeneous granular deposit of calcareous matter—

It is * * * deep—half way down it was divided horizontally by a blackish seam a couple of inches thick—extended about a yard in circumference—The stratum consisted of charcoal mixed with decomposed animal and vegetable matter—from the midst of which were extracted two portions of the Jaw, a tusk and some of the phalanges of a Boar—The animal remains acquired their color perhaps from their long residence in the charcoal which however appears from the burnt state of the bones to have been employed in roasting them—The lower half of the stalagmite was like the upper devoid of all extraneous matter—

The soil beneath it we shall describe when we come to treat of the vestibule of which this wing is only a continuation. We shall merely remark that the earth was freer not only from bones but also from rocky fragments than the central chamber—being skreened from this accession from these upper levels by the same cause which guarded the stalagmite the gravel was the same however and the bones tho more sparing equally characterized—

[71] We shall not stop at present to state the reflexions suggested by the singular fact we have just noticed, but continue our route in the arcade. Length * * * * Height and breadth of arcade * * * *

It has been remarked that the floor was divided between masses and pools of water—the latter were encircled with wavy walls rivalling the most exquisite works in pastry thrown up by the drop as it fell into these basins impelling the spray to the edges or sides—and throwing up around pasteboard like enclosures—

Between the rocks and overspreading the stalagmite appeared loose heaps of red marl containing fossil bones—In this loose heap it was that I found the first Rhinoceros' tooth, which I presented to a Lady at Torquay who had a collection of objects of natural history from the environs of Torquay—I had not yet commenced forming my own collection.

It was merely a repetition of the phenomena of the upper chamber and referrible to the same cause—But what was peculiar to this passage was a profusion of white crumbling substance not unlike half slacked lime—Rock after rock as we turned them over presented patches of it on their surface—the loose mud contained it likewise—and wherever stalagmite had formed between the rocks when ripped up it exhibited large deposits of the same matter—In the crevices of the rock and near the surface of the marl we discovered it in balls partly crushed—and as we proceeded collections of them

imbedded in the mud, which left no doubt of their nature and origin.

In some instances several of them were pressed together as in other times singly, coated over with a pellicle of stalagmite or a thin slime—

This passage was in consequence appropriately called by Dr. B, to whom I pointed out the accumulation—The *Hy cloaca maxima*—

Cave of Inscriptions.

[73]

The observations that have been made on the arcade are applicable to this chamber of which it is indeed only the continuation and boundary—the same irregularity of floor—the same abundance of *album vetus*—but there are certain characters peculiar to it and the Bears den, which distinguish them from the rest of the cavern—

First, the predominance of one particular species which (to the exclusion almost of the rest) commences in the arcade.

2dly. The dislocation of the stalagmitic floor and the depression of the level of the mud the cause of it—

The floor exhibited the greatest confusion—the stalagmite was broken and thrown on its edges and the red marl left partly exposed—It was [where] so lying exposed was found by Mr. Welland the lip of an enormous Bear. I also found under the same circumstances a considerable number of the remains of the same animal in different stages of preservation—Some of the specimens were discolored by contact with charcoal, used for fires—Here were found clusters of tubes or icicles in hollows. The change of level is best observed at the sides—The soil may be seen separated by space of * * * * from its former crust which continues in some places to maintain its position spreading above the space like a mantle—

An interesting example on a small scale is what is termed “the saddle,” on the right of this chamber under the wall of the chamber—in a piece of stalagmite which took the undulating form of the earth on which it moulded itself and which it retains notwithstanding the separation of the soil—

Before the subsidence the soil rose to the height and touched the base of the curtain of rock below which it has fallen so considerable as to permit a person ranging through it on his face—Its former height is indicated on the rock not unlike a water mark—

Labyrinth and *Oven* converge in the Bears den—

[75]

The passage leading from the arcade into the Bears den is

by far the wildest part of the cavern—The path lies over rugged ledges and through intricate windings; the rocks descending half way down in inverted pinnacles, through which it is necessary to tread with caution, for while attending to your feet you are in danger of knocking your head—more than one has carried home contusions to remind him of the Rocky Labyrinth—which without a figure it may be called—

There was a tradition of the loss of life here by a young man who ventured to explore it without a guide—It is certain that two gentlemen who lost their light and way in this spent a night of horror here—Dreading to advance for fear of falling into the pits of which we shall have to speak, they remained immovable until their friends came to their relief, alarmed by their absence—

No where in the cavern does the rock show itself as here in such quaint mouldering masses, through which the calcareous veins and organic remains protrude in relief, the softer portions being eaten away by age and moisture they are pierced through with holes and seem to threaten to sink under the weight of the vault—In the other parts the Stalactites glazed over the surface and defended them from decay. In this they were left naked—

Here again the soil (that is the red marl) was scattered over the rocks and stalagmite and much tumbled—In it were detected the remains principally of Bear—discolored and decayed—The stalagmite was of course irregular—where it covered the red marl it disclosed the remains of Bear exclusively in the highest and most brilliant preservation, almost surpassing in freshness and lustre all I have ever seen of modern bones—

[77]

Bears Den.

A curtain of stalactite? with depending clusters of spar at certain intervals with corresponding eminences on the floor was the picture this chamber presented when we first saw it. It was floored through its entire extent with a continuous sheet of stalagmite siliceo-calcareous and crystalline, so difficult to penetrate that after repeated attempts we abandoned it in despair. At length availing ourselves of cracks that traversed it like the divisions in a pavement we succeeded in ripping it up. All we had hitherto observed vanished in interest before this disclosure. The first flag that was turned over exhibited in relief groups of skulls and bones adhering to the stalagmite—Each successive flag repeated the same spectacle—It is to be regretted that their size prevented us

from transferring them at once as they were found to our museums—for while they lay in the chamber awaiting their removal some persons who had heard of the discovery broke into the cavern and either tore away or disfigured the masses—sufficient however have been preserved to give an idea of the accumulation and character of the remains in this quarter.

The calcareous matter was mixed with sand (that came down during rains). So highly crystallized was the stalagmite that it struck fire with the pick-axe—As we penetrated into the marly deposit we found it indurated by the infiltration of the same matter and thickly impregnated with the oxyde of iron—It was necessary to break it off by piecemeal—The bones in consequence seemed to be mineralized—they were double the weight of those in the other chambers—were brittle and broke sharply off like petrified substances—We found this was owing to their cavities being filled with crystals and their pores completely penetrated with the oxyde of iron—The essential nature of the bones were not altered as we afterwards ascertained—^[79]

(In none of the chambers has the stalygmite been so highly crystallized and the fossil remains in such brilliant preservation—or so heavy, so brittle and so {short} {easy} of fracture—) and ring when struck like {mineral} {metallic} substances.—

The remains of Bear prevail here to the exclusion of all others—of all ages—and of all periods brought down to their encasement in the mud—some of the teeth are of the most dazzling enamel and the bones of their natural freshness as if derived from animals in high health destroyed for the sake of their skeletons—

Others on the contrary are of a darkish brown the texture of the bone decayed from long exposure—and only kept together by the calcareous and ferruginous matter with which they are saturated—Even the enamel is of a greenish tinge—Owing to the induration of their earthy envelope or their incrustation by stalagmite few were extracted entire—Two skulls were buried in the stalagmite as in a mould and were brought away in that state—The spar has formed into a variety of spicular crystals in their chambers—

The skulls were severed in two, fronts separated from the occiput and found apart—the other portions of the skeleton lay about in all directions without any order generally, tho we were able to trace the natural relation of the parts in some instances—

But in no case were they or the skulls broken or gnawed

like those in the other parts—The long bones were found generally entire, and when observed broken, it was only mechanically from pressure.

- [81] In no instance have they exhibited {indications} {signs} of being broken or gnawed by the jaws of carnivorous animals for the sake of their flesh or marrow bones. In fine they were precisely in the state of bones that belonged to animals that died by a natural death on the spot during a succession of ages, whose remains had long lain about on the surface, subject to being trampled upon by the feet of its own species that made this branch their haunt—

In this respect this section of Kent's Hole resembles the caverns of Germany in the predominance of the Bear, in the identity of the species and in the unbroken condition of the remains—

It is worthy of remark that the remains of the *Ursus cultridens* do not appear here no more than among the Bears in the German caves, tho it does as we shall see in the other chambers with *Elep*—

To enhance the wonder of this anomalous scene, there appeared, and there still exist attached to the under surface of one of the pyramidal mounds remaining in this chamber, lumps of album græcum—but of other traces of the presence of the *Hyæna* there is not a shadow, or indeed of any other animal—except in its outskirts—as shown by the fractured jaws of *Ursus spelæus* and *cultridens*.

In the German caves we know that the remains of the *Hyæna* generally accompany those of the Bear—under such circumstances too as to warrant the inference that they certain species at least if not all lived in good intelligence together.

- [82] But we have not yet done with this chamber—In the centre of it there was a double floor of stalagmite—between which was interposed a stratum of rubble, sparry pipes, a black flint knife, and spots of charcoal with shells of muscle and oyster but no red marl—or its usual contents.

The rest of the floor was regularly stratified in red and white laminæ—exhibiting no vestiges of adventitious matter—or of interruption.

The position of the rubbly stratum occurring half way down the section of the stalagmite inclines me to refer it to the same cause and epoch as the seam containing the Boars remains at the entrance of the Arcade of which we have already spoken—

Subsidence of Marl—change of level of the contents of the basin [86]

The interest of this region is not yet exhausted—mention has been made of pits in the floor, into which certain bewildered visitors were in apprehension of falling—they are situated to the right beyond the Bears den.—

Hooking on to the sides with hands and feet you alight into a second cave below that which you had been exploring and of the existence of which you had no suspicion while walking securely on the surface.

There are two and in some parts even three underground stories through which it is possible to range.

In some places the space is sufficiently lofty to permit standing upright—but towards the verge it contracts—obliging the explorer to creep along flat on his face—

It spreads co-extensively with the upper cave and even stretches far beyond its limits under the actual wall which only drops half way down like a curtain expanding with the base of the hill or its rocky shell.†

In this second substalagmitic range occur phenomena that are calculated to lead the inexperienced to false conclusions—Above his head appear bones adhering to the roof—under his feet they protrude from the floor or lie loosely over its surface—From these startling facts he might be tempted to {infer} {imagine} the existence of at least two distinct deposits—{If he will however examine more attentively} {but before {more attentive} {closer} observation} the difficulty will vanish as patches of stalagmite may be observed at certain intervals adhering to the floor—which were torn from the roof above, and which {left} {caused} those cavities in the upper level that gave him access to this region—he will further remark the absence of a continuous crust beneath. In fine by coupling the appearances of the floor with that of the roof he will perceive that the intermediate space was created simply by the separation of the earth from its covering, in consequence of a change of level in the former—on a grander scale than those in the cave of Ins. [scriptions]

In consequence of the absorption of its moisture by the [87] air the mud mouldered away round the fossils, drawing some after it on the floor, or leaving them detached in their bed—

The change of level is confined to the region on the right and left of the arcade—It does not extend to the vestibule

† Schmerling and others have noticed teeth glued to the vaults or naked [84] on the floor, probably explicable on the same principle.

we set to work at the removal of a column of spar which joined the ceiling and floor and obstructed the way into the suite beyond—After great labour {we succeeded in dislodging it} {it was dislodged}, when to our inexpressible surprize and joy we found it had covered the head of the wolf (fig. p.)† perhaps the largest and finest skull, whether fossil or modern of that animal in the world—near it lay one of its under jaws entire—the other notwithstanding the most diligent search we failed in recovering.

This obstacle removed we burned with impatience to penetrate into the chambers beyond—As a Grotto hung with curious concretions of dazzling brilliancy it well repaid our search—the floor sloped upwards and conducted into two ovenshaped branches which it threw off to the right and left—similar to those near the common entrance and with which the one on the right seemed to communicate, tho partly closed up at present by stalactites, that on the left seemed to pierce thro the boundary wall of the cavern into the open air—

We now returned to the excavation which produced the wolfs head—the stalagmite was about a foot and a half thick and of excessive hardness in which were imbedded rocky [92] fragments rolled down the slope—but as we advanced inwards the stalagmite became altogether free from foreign admixture, and moulded itself upon the mass of bones—Of the quantity and condition of the remains here it is scarcely possible to give a just idea without appearing to exaggerate—They were so thickly packed together—that to avoid injuring them we were obliged to lay aside the picks and to grub them out with our fingers. They had suffered considerably from pressure after having first undergone violence from the force which impelled and congregated them in this narrow neck. They were found driven into the interstices of the opposite wall or piled in the greatest confusion against its side, with but a scanty covering of soil and that of the finest and softest sand intermixed with greasy earth—To enumerate the amount of fossils collected from this spot would be to give the inventory of half my collection—comprising all the Genera and their species including the cultridens, there were hoardes—but I must specify jaws and tusks of the Elept. with the teeth in the sockets and the bone of which was so bruised that it fell to powder in our endeavour to extract it, a rare instance of the teeth occurring in their jaws or gums—The same may be observed of the jaws of the Rh., one portion alone of which was saved—but the teeth of both were numerous and entire.

† [Probably Pl. G., "Cavern Researches."—W. P.]

The teeth of the Elk, Horse, Hyæna were taken out whole—The teeth of the two last were gathered in thousands—and in the midst of all were myriads of Rodentia. The earth as may be expected was saturated with animal matter—it was to use the expressive words of my fellow laborer Walsh, fat with the sinews and marrow of more wild beasts than would have peopled all the menageries in the world.

- [93] The long bones abounded no less than the jaws, generally bruised and split longitudinally—but without an exception they had been broken and gnawed that is they had passed thro the jaws of carnivorous animals before they were subjected to the violence which crushed them.—

Intermixed with them at lower depths was sand and gravel, and marl, angular and rounded fragments—the former generally limestone—flat masses of which had fallen into the heap from the roof, where its under surface was coated with stalactites—cones and slabs of the latter scattered thro—schists and slates and grauacke angular and sharp. The rounded substances consisted of small pebbles of limestone chert and quartz, green and sand stones—

This passage my companion called the grave of the wolf from the circumstance of the Pyramid that rose above its head—

[94]

Cave of Rodentia.

We literally drove a lane through piles of bones in our {passage} {progress} to the inner grotto—There again a new spectacle opened to us—no longer or but rarely had we to do with the great quadrupeds—these we left at the entrance—we now found ourselves in the midst of hundreds of Rodentia. Of their remains and dust the deposit was constituted, agglutinated together by calcareous matter into a bony breccia. It should have been premised that the stalagmite above them was about a foot and a half deep?—regularly laminated and free from all adventitious matter—being a solid concretion of lime scarcely yielding in hardness to that in the Bears cave—It suffered no disturbance or interruption from its first commencement—The floor and ceiling announced a grotto in its virgin state that had been closed against all intrusion since the deposition of its materials—The remains of Rodentia were wanting in no part of the cavern that we had yet examined—They were generally discovered near the surface of the red marl—(I do not of course speak of the recent skeletons of Rat and Bat found in the cavities of the crust)—but here in this grotto they swarmed in countless multitudes

--not only had their tiny remains penetrated into every cleft and crevice of the rock but they insinuated themselves even into the chambers of the large bones—the wolf's skull in the passage had its cavities charged and its surface encrusted over with a concretion of their bones.

When first I contemplated this congregation of minute skeletons I was prompted to suppose [them] the spoils of animals that had been overtaken by the calamity, from which they rushed into this grotto for assylum.

Nor is it unlikely that at the moment of the irruption of the mud thousands had so perished—but it was not of animals destroyed by a sudden catastrophe that this heap is made up—Before they were injected into the fissures of the rock and chambers of the bones they must have been already divested of flesh. They lay loose and disentangled at the instant that the fluid caught them up—and that washed into {situa- [95] tions} {places} where they could have never penetrated without its agency. Evidence of this is found in the fine sandy sediment which entered with and enveloped them in their new abode.

That they existed and died here is still further confirmed by the condition of their remains—they are indications of all ages and stages of preservation and still furnished with their most delicate and fragile processes, announcing successive generations which died here peaceably in the course of nature during prolonged habitation of this grotto by their race—Add to which the marks of small teeth on the large bones accumulated at the entrance—the generality of them were scratched transversely as with the edge of a file—there cannot exist a doubt that these impressions were made by small quadrupeds which feasted on offal rejected by beasts of prey.

Had they been washed in with the mud, it must have been either with their carcases entire or despoiled of their flesh—

In the former supposition they could not have entered into the narrow and intricate recesses of the large bones—and in the latter, instead of occurring congregated into a mass in a particular spot, their loose bones would have been equally diffused over the cavern—

It was an interesting spectacle to behold myriads of minute animal remains congregated by the side of Elephants, R. and H. in a common sepulchre—Heads generally crushed—Lower jaws preserved—when a handful of this dust was thrown into water, hundreds of teeth rose to the surface, and it was by this means they were collected.

In this heap were found intermingled two species of

Rodentia, the Land and water rat (or camagnol) Bat, weasel and mole†—

- [97]† *Vestibule, or Sloping Chamber*, or hall of communication with all the branches—divides off the body like a spine the upper Gallery by a partition of rock, which separates the upper Gallery from the lower—In the latter it forms a species of curtain along its left flank, beneath which we pass stooping into the Labyrinth, Bears den, all which no doubt communicated with the upper Gallery before the elevation of the floor by the mud and stalagmite and fallen masses—

We have reserved the notice of this chamber to the last, it being by far the most considerable for its size and its fertility in remains—The arcade or cloaca on the one side and the wolfs passage on the other may be regarded as only its appendages—but in its admeasurement and examination we shall confine ourselves to its limits as defined by its walls—

Measured from its wall on a line with the mouth to the opposite one at the foot of the slope it * * * * and across * * * *—From the rapid inclination of the floor it is characteristically styled the Sloping Ch. There is * * * * difference of level between the up and lower level—

† *Note on Rook Pye.*

Even at the present day tho there are no longer beasts of prey to purvey for their table, (which it is served and that with pyecrust and pigeons bones and such casual fragments as are dropped by visitors,) rats are abundantly numerous in the cavern as we had reason to feel on more than one occasion—Instead of bringing out each days supply, we laid in a stock of candles for a week, put them away carefully on a lofty shelf of the rock, to be used as wanted—next day we found only the paper envelope of the parcel.

- Not long after they visited us with a less pardonable grievance. A gentleman of Torquay compassionating our neglect of dinner hours in our enthusiasm for research very considerably provided a huge rook pye that promised to stand a weeks assault at least—After partaking it once we deposited the rest in a species of cupboard at the end of the common entrance—(one of the offhoots of which mention has been made) having first taken the precaution to wrap it up in sundry folds of napkins—next day at the close of more than usual exertion, thro which we lost not sight of the treat in prospect, we repaired to our larder—there to our surprise remained but the dish, the cloths having been pierced thro in all directions—It was now clear that there still existed in the cavern marauders that loved Rook pye as well as their predecessors did widgeon—the bones of which we picked out in the cave of Rodentia, the extremity of the oven-shaped cupboard—
- [27] *Vestibule at all times the receptacle of casual matters*

- [95] In the caverns of Liege they were equally abundant—"Parmi ces depouilles de rongeurs, ce sont certes celles des campagnols qui sont les plus abondantes." Dans quelques localités la nombre en est tellement prodigieux qu' en quelques instans on en recueille une quantité considerable—

A Chokier, a Engis, a Fond-de-Forêt, a Goffontaine, en un mot dans toutes les cavernes on j'ai fait des fouilles, jusqu' a ce jour toutes nous ont fournies des debris de campagnols fossiles" (Schmerling P. 102. Second Partie.)

† [There is a duplicate "page 97." W.P.]

Its roof is * * * high—pierced with spiral holes and clefts in all directions but closed at the surface—through which flowed copiously the calcareous matter (consolidated into massive pendants, known as the chandeliers) the surplus of which fell on and formed the floor in a variety of concretions.

The upper level owes partly its elevation to large time severed masses detached from the roof by vicissitudes of temperature—(their former place may be traced on the roof.) Similar blocks are scattered down the slope occasionally imbedded in the floor. In addition to these, angular fragments (derived chiefly from the waste of the rock) swell the centre—accompanied by the remains of stray animals or of such as retired hither to die, and articles of wood and flint dropped by visitors from the earliest periods down—the whole cemented together into a solid mass by calcareous infiltrations producing the same effect as liquid lime poured into a stratum of loose materials—

Thus by degrees was formed the present floor of chemical precipitates blended with mechanical deposits to which from the incrustation of its undulating surface the guide gives the name of “the frozen billows.”

The earth upon which it moulded itself is nearly through [99] its whole extent excavated away, for it was found more convenient to undermine than to break it—it continues nevertheless to span over the chamber like a natural vault over a gulph—

The crust is thickest in the middle—towards the sides it thins away—for opening the excavation the same means were employed as to break up a mass of ancient masonry.

Flint blades were detected in it at all depths even so low as to come in contact with the fossil bones and their earthy matrix—but never below them—occasionally long bones protruded upwards thro it, (having received that vertical position at the settling of the mud) and were surrounded by incrustations—but in no instance have teeth or small fossil bones been perceived in the crust—

In this receptacle were found {collected together the remains} {interspersed thro with enormous quantities} of all the animals, which had appeared separately or but sparingly in the other parts. and it was remarked that among the heaps there was scarcely ever seen an example of an entire bone—all almost without an exception, Jaws and teeth as well as long bones, were broken and gnawed as {exhibited} {represented} in Plates—† Instead of entering into the particulars

† [Probably Plates P, Q, R. “Cavern Researches.” W.P.]

of each individual specimen here, which are treated in detail in another place. It may be curious to show the order in which the materials generally lay, as far as a general law can be applied to such a confused mass, for the interposition of large detached ledges thrown across the excavation in the midst of the deposit often altered the arrangement. The disposition of the fossils and quality of their earthy envelope were as follows:—

- [101] Immediately under the stalagmite the deposite consists of a fine, soft sandy marl composed of impalpable particles—In many places it had escaped altogether, leaving void spaces of several feet around—the remains at this stage were generally a few small light bones—both they and their mineral accompaniments (such as fragments of limestone &c.) where the earth had escaped were invariably invested with a thin dry coat of the red mud. (It reminded us of the slime that hardens on rocks in ponds during periods of drought.)

Lower down say 1 ft to three, they became most abundant, usually large bones, such as the bases of horns and palate of Elk and the solid * * * of the bones of the Pachydermata—At this point the earth gets generally interspersed with pebbles and larger fragments of rock and spar.

From three feet to six, the remains diminish in quantity and increase in size—at this depth were extracted the heaviest bones, such as the humeri of Elepht. and Rhin. the skull of Hy (loaded with mud). The earth at this depth “more rubbly” as the workmen termed it—filled with blocks of limestone and spar—ranging from pieces of a foot long to several feet—in the midst of them was picked up the ball of granite which has excited so much sensation.

Below 6 feet the difficulty of penetrating increases, in consequence of the accumulation of large masses of limestone exclusively—we however succeeded in sinking a shaft to the depth of 30 feet at the bottom of the slope, with the view of reaching the original floor—we had to pierce thro loose ledge after ledge of limestone accompanied with coarse rubble—(the detritus of the roof and sides) meeting with rarely a vestige of bone—The few that were detected were much {discolored} {decomposed} and bruised—or so soft from over saturation with moisture during their long immersion that they crumbled at the touch, but as there was as little apparent chance of arriving at the bottom as when we started, we gave up the pursuit in despair. It seems that the floor at the period of the addition of the mud, that which the animals walked upon was {about} {at most no more than} 5 or 6 feet below the stalagmite.—

A propos of blocks of spar—About 5 feet down in the ex- [102]
 cavation we encountered one of feet 5 in diameter nearly globular—that had been apparently detached from the roof—Having carried our section close to its side, we were proceeding with the shaft, when it rolled down into the pit—Most fortunately we were advertised by some particles of earth that ran down the side, of its loosening—There was only time to throw ourselves back on the excavated heap and at the expense of a few bruises so escape being crushed—

It may not be out of place to mention here that during our operations in this excavation we were assisted among others by Viscount Valentia and Mr. Henry Maxwell, who succeeded in digging out some of the choicest *treasures*—

On other occasions I was attended by Lord James O'Brien and other enlightened lovers of Natural History—Lord Newark—Lord Henry Carr.

Among the scientific men who occasionally labored with me I should not omit the late venerable Dr. Beeke, the Bishop of Bath and Wells, Revd. Dr. Cooke of Gloucester, Dr. Mac Turk of Glasgow, Mr. W. C. Trevelyan, Sir Bald * * * Sir T. Ackland, Marquis of Southampton [? Northampton]—Mr. Curtis of Teignmouth, Mr. Croker of Bovey, Revd. Mr. Lyte—Rev. Lawrence Welland, Mr. Featherstone of America—

And on several occasions by Dr. Buckland, to whom I was desirous to point out on the spot the position of certain flint knives and the alternation of the stalagmite with mould in certain chambers. the solution attempted of which I have arrived at myself by slow and deliberate observation, uninfluenced by the authority which his eminence in science justly commands.

I avail myself of this occasion also to record the labours [103]
 of two enlightened clergymen in the same field. The Rev. F. Belfield availed himself of the permission of the Proprietor to open an excavation in the vestibule, the fruits of which among other precious results were teeth of Elephant, one of which belonged to a very old animal—the bony substance between the enamel having been decomposed during its submersion in the mud left the transverse ridges of enamel in relief, exhibiting their wavy lines, peculiar to the Asiatic variety (to which it has the greatest affinity) in the most beautiful order—It is * * * long—and by the solidity of its fang shews that it was only just expelled from the mouth.

The Revd. Lawrence Welland a near relation of Sir L. Palk likewise pursued investigations in this cavern, and with ex-

traordinary success. The lip of the Gigantic Bear (fig. P.)† was discovered in the cave of Inscriptions by Mr. Welland—I have compared it with the fossil jaws of the Bear from the caverns of Germany in the collections of Paris &c. and have found none equal to it in volume—It must have belonged to an Individual of prodigious size not inferior to the largest Buffalo—or Ox—

Mr Welland also was fortunate in making other discoveries sufficient to form a curious collection of the Fossil R [emains] from this cavern—

Sir Lawrence possesses a similar series—

[105] (*Substratum of disintegrated Limestone*)

It may be desirable to enter into a more particular examination of the divers ingredients which fill the bottom of the cavern—and the mechanical arrangement of the materials—We shall commence in an ascending line from the bottom reversing our former order.

The substratum of the deposit of mud and stalagmite, and that which seems to lie in immediate contact with the rocky bottom of the cavern is constituted of disintegrated portions of the bounding rock or shell of the cavern itself, viz. large detached masses and comminuted fragments of limestone;—the former appearing precisely in the state they fell from the roof (their ancient position in which may still be traced in the parts not yet encrusted,) and the latter generally angular, partly derived from the breaking up of the large blocks in their fall against others and partly from the detritus of the crust during successive periods of frost and thaw, cold and heat, such changes of temperature as reduce the surface of all strata to the state of rubble and soil—‡

- [111] We sometimes remarked that the Limestone was coated on one side with stalactites, incontestably proving its having once made a part of the surface of the cavern—but not the least remarkable incident was the fragments of stalactites and stalagmites—the latter were broken into small slabs, and dispersed thro the mud not unlike pieces of ice in a river—the slabs did not exceed 10 in. or a foot thick—but there were of it of all degrees below that—in pieces generally a foot square at most, not rolled—laminated—ordinarily much decomposed—

† [Fig. 2, PL D, "Cavern Researches." W.P.]

‡ [The lower half of the leaf has been torn off and is missing. Pages 107, 108, 109, 110 are missing. W.P.]

The blocks of spar were of all sizes from the thickness of the finger to the bulk of the enormous block buried in the centre of the vestibule—specimens are preserved of the smaller stalactites—one of which a foot and half long struck us as particularly curious—from the character of its concentric {circles} {zones} it was one that *capped* the floor—neither large or small were rolled, simply broken off by the irruption of the mud in which they are buried—The large mass most probably occupied the place of the present chandeliers—†

Equal and identical muddy deposit

[113]

It has been shown that the fossil contents vary with different parts of the cavern. In some the Remains of Hyænas and Herbivora predominate as in the Vest^o.—in others, the Bear as in the Bears den—and in a third Rodentia, but in all their matrix is essentially the same, modified only by a greater or less infusion of calcareous or ferruginous matter contributed {from} {by} the roof and sides {since} {subsequently to} its deposition.

The proportion of animal matter incorporated with it may be greater in certain places as in the wolfs passage—where the earth is larded with it—but these considerations are extrinsic to its character and do not alter it sensibly—The same body of mud is nearly equally diffused over the bottom of all the chambers—and is alike in all—In the vestibule it retains its form of mud—†

Resumé or summary

[120]

Such were the constituents of the great deposit beneath the stalagmite in the bottom of the cavern—And such their condition—

1 It has been seen after a scrupulous and careful analysis of this, that it consisted in its lowest member of the fragmentary detritus of the cavern itself reduced in the lapse of time by the vicissitudes of temperature to comminuted *rubble*, interspersed with tabular masses that were loosened from the roof by the action of similar causes—

2 That superimposed and in places occasionally intermingled with this bed was another stratum leading up to the crust composed, in addition to the substances just specified, of multifarious materials—viz. red marl identical with the

† [The lower half of the page is missing. W.P.]

‡ [Pages 115, 116, 117, 118, 119 are missing. W.P.]

superficial covering of the circumjacent district—reduced to the state of a muddy sediment, mingled with sand, silt and gravel, angular fragments and nodules of rocks foreign to that of the cavern—and referrible to distant formations—to which were added columnar and flat pieces of spar, apparently the ruins of a former ceiling and floor—displaced on the occasion of the influx of the aforesaid materials.

3 Through which were distributed the remains of Herbivorous animals and of beasts of prey, both classes of numerous genera and species of every gradation of age and stage of preservation—

4 That these remains were generally mutilated and marked with the impressions of teeth—

5 And that thro the whole mass was disseminated fecal substances attributed to (predaceous) animals.†

[124]

Generalizing

In the condition of the substratum of rubble we behold the effects of atmospheric causes similar to those in actual operation in wearing down the surface of the rock and depositing the disintegrated debris on the bottom, during the lapse of a considerable period of time—In a word the lower depths of the cavern were precisely as they should be expected to be, viz. strewed over with the waste of the rock—during the accumulation of which it appears to have been not at all or but thinly inhabited—This appears to have been the ancient floor, on which were deposited the animals remains, previous to the addition of their muddy envelope—

After the data furnished by the cavern itself it seems superfluous to prove that these remains were the greatest part brought hither in their mouths by beasts of prey, which made it their dwelling—and which perishing by violence or natural death, in their turn left their own skeletons on the floor, confounded with the bones of their prey, and liable to the same fate. Upon no other {ground} {Hypothesis} can we explain the accumulation of the mangled bones of such a multitude of Herbivora and carnivora.

[125] If it be asserted that they were transported from the plains by the muddy vehicle—this objection is instantly met by the condition of the bones which however much fractured and gnawed, exhibit their sharp angles and where they retain their processes, it is almost invariably in all their integrity—

† [The bottom of the page is torn off, and pages 122 and 123 are missing.—W. P.]

Even the most fragile jaws retain their milk teeth as in Fig. * * † and their salient ridges.

And the balls of album græcum exist in the state as after their expulsion they were deposited in groups compressed against each other—

In such a hypothesis too they would be found equally diffused through all the chambers indiscriminately, instead of being congregated in particular places and of being almost absent in others—

Album Vetus.

[126]

The depot of Fœcal deposites in the corrydor, adjacent to the grand repository of mutilated remains, has found an analogy in the condition of the Living Hyænas retreat such that seems to dissipate all doubt on the subject—"I have to remark" (observes Cap. Sykes in his communication respecting the discovery of a modern Hy. den inserted in the Edin. Phil. Journ., Jany. 27) † "a very singular fact with respect to the habits of those carrion beasts. It was evident from the accumulation of dung on the same spot, in a hollow about ten ft. from the entrance of the den, and from this substance not being found in any other place, that these beasts young and old resorted regularly to a chosen spot—in short that they had thought it necessary in their domestic arrangements to render a spot sacred to the Goddess," &c.

That the corrydor was the chosen resort of beasts of prey for purposes of cleanliness, we concluded from the circumstances already exposed long before the above curious statement made us acquainted with the manners of the modern animal, and since 1826 applied to it as its most significant appellation of the "Hyænas cloaca." It has been seen that there was no depth where stray patches of it may not be detected, generally reduced to a white powder and seldom whole.—no doubt swept away from its depot in the turmoil—

It should be further remarked that wherever this substance is found accompanying remains, the bones are invariably broken and always in the same uniform manner—and that none is found where they occur entire—The vicinity of the Bears den, into which it was most probably carried by the mud, accounts for its presence among unbroken bones in that particular chamber.

† [The author probably alludes here to Fig. 8, Pl. M, "Cavern Researches." W. P.]

‡ [Letter from Captain Sykes to Dr. Buckland. Edin. New. Phil. Journ. vol. xvi. 1827, pp. 378-9.—W. P.]

The l'Abbé Croizet detected heaps of it in a loose bed of alluvium in a valley in Auvergne in the midst of remains of the same fossil animals of the cavern—He observes it was of different sizes perfectly characterized, often connected together and to occupy the very places where it was deposited—The bones were broken and gnawed in a manner so precisely similar to those from Kent's Hole that the plates of M. Croizets work would equally serve to represent the animal remains of that cavern—

He remarks "qu'il y ait des os rongés par les carnassiers, que presque tous soient brisés et jamais roulés, que les membres soient si souvent épars, que *l'album vetus* avec toutes ses [128] extrémités les plus aiguës, soit si bien conservé et réuni par places dans un certain ordre."—from which he concludes that "les ossemens rongés de ceux-ci, *l'album vetus*, sont les débris abandonnés par les carnassiers qui dévoraient les herbivores sur le point même où nous les trouvons aujourd'hui."—

He further adds "La réunion surprenante de ces débris permet de croire que les herbivores étaient entraînés par les carnassiers vers des lieux déterminés qui servaient de point de repaire. Il n'y avait pas de cavernes comme celles qui ont été décrites par le célèbre Buckland et M. Marcelles de Serre; mais les causes d'entassement sont probablement les mêmes."

(Page [92], 94–95 Recherches sur les Ossemens [Fossiles du Department] du Puy-de-Dome, [par l'Abbe Croizet, et Jobert aîné, Paris, 1828.])

In this way may be accounted for insular {depots} {groups} of bones found in superficial beds at different points of the Earths surface, in which the remains of Hy are generally present.†

[129] When a natural and obvious solution of a difficulty offers why seek for a remote and possible one?

The conclusions at which the above named naturalist arrived from a display of similar phenomena are the same which we drew from an examination of those in the cavern.

[128]:

Rongeurs.

Le gisement des os de ces petits animaux n'était pas à beaucoup près partout le même; ainsi dans la caverne de Chokier il s'en trouvait contra la voute d'engagés dans la stalactite; dans la brèche ils accompagnaient ceux d'espèces éteintes et en grand nombre. Ils n'étaient pas rares dans les

† [The lower half of the leaf is missing. W.P.]

‡ [There are duplicate half "pages 128 and 129." W.P.]

couches de stalagmite ; on en trouvait aussi dans le limon ; mais le plus souvent on les rencontrait dans les feutes latérales de cette cavité, et ces ossemens se trouvaient en grand nombre entre des masses de pierres ebouliées, sans qu'il eut le moindre trace de limon.

Il parait que les débris des familles entières de campagnoles de petites espèces y ont été déposés et s'y sont conservés d'une manière vraiment étonnante

Assurément ils ont vécu près de ces lieux ou ils ont été ensevelis, là où l'accès des agens destructifs a perdu toute influence.

Ils ont pu séjourner à côté de débris d'êtres dont les analogues n'existent plus. (104 Schmerling Parte 2—)

Nests of nuts bored at one end through which the kernel [129] was extracted found in the hollows of the stalag and diluvium—recent ?†

Rodentia

[134]

If we were not embarrassed by the abundance of proofs of the occupation of the cavern by beasts of prey, the extraordinary congregation of Rodentia would alone be an argument *a priori* of the existence of a depot of offal in their neighbourhood. It is well known they are attracted in thousands about voeries by the carrion collected there—and if we had never discovered the heaps of bones which crowded the passage into their den, we should have been authorized in presuming the existence of them.

I am aware that the great majority of those small quadrupeds belong to the species of the campagnol or Field rat—the existence of carnivorous species is indicated by the impression of their teeth on the large bones few of which escaped their nibbling after they fell from the Hyænas mouth.—Perhaps by the weasel whose head is fig—P—||

Conclusion from Den

[135]

It seems established from an unbroken chain of evidence that the ancient floor of the cavern was covered with the remains of animals which made it their habitation such as the Hyæna, Bear and Campagnol—the two latter occupying its opposite extremities, and the former the rest, comprehending the centre and upper gallery—

It further appears that the Bears den was peopled exclu-

† [Pages 130, 131, 132 and 133 are missing. W.P.]

|| [Probably Fig. 17, Pl. E, "Cavern Researches" W.P.]

sively by generations of that animal—in which respect this branch of Kents Hole resembles the caverns of Germany—And that the cave of Rodentia was inhabited chiefly by the Campagnol. But that the great body of the cavern was occupied by the Hyæna, and that in addition to remains of its own species which perished in it {by a natural death} {the course of nature} were found those of its prey, accompanied by other evidence of the conversion of the cavern by them not only into a den but likewise into a repository of their prey. To which may be added as a corollary the absence of all proof of their being conveyed into it by the same agency that transported the gravel—

Thus resembling the cavern of Kirkdale—Kents-Hole unites the characters of the 2 great divisions of caverns—

- [136] That while in this state the floor was surprised by a body of mud which swept up and confounded promiscuously the materials lying upon it—

And that this body of mud so covering the bottom of the cavern was derived from without and impelled inwards in a fluid state.

And that it was composed of the adventitious transportable materials which it collected in its march, vid. sand, clay and gravel—

That there is evidence of only one such irruption—and that there is no evidence of its having been preceded or followed by another. (Quote Cuvier and Dolomieu.)

[138]

Diluvium.

From an inspection of the composition, compound character, of the deposit reposing on the substratum of rubble and enveloping the bones, it is certain that it is merely the sediment of a fluid that held in suspension clay and gravel, which it swept up in passing over the surface of the adjacent [140] country† and threw its waves into the cavern in a tumultuous state is manifest from the ruins of the ancient roof and floor buried in its sediment, in the shape of loose cones and slabs of spar—and in the accumulation against the opposite walls of heaps of gravel and bones—

- [138] † In addition to the derivative debris of all the circumjacent formations, it contains rolled fragments of rocks transported from a distance—viz. from the great granite chain about a dozen miles from the cavern.

So persuaded was the Revd. Mr. Belfield of its having once been the superficial soil of the plains that he had parcels of it laid out in his conservatory in the hopes of raising from seeds possibly preserved in it plants peculiar to that order of things, which would be found differing from those of the present vegetable no less than the animal kind.

In the upper gallery they are so thinly dispersed that their existence is only traced by a straggling bone †

At the foot of the slope splinters of bones and of stones were driven into the {crevices} {interstices} of the rock and the remains of rodentia accompanied by fine gravel injected into the chambers of the skulls and long bones, places into which it was impossible for them to have penetrated without the agency of a fluid in violent commotion.||

Fragments of Jaws and bones perfectly corresponding, that [139] had been divided not by the teeth of animals but by mechanical force were picked up in the upper and lower gallery, at the distance of 70 feet from each other.§

But that it was as transient as it was violent appears from [140] the unrolled condition of the bones and still further from the state of the album vetus—The great majority of it was detained in the narrow strait where it was deposited between upright walls in heaps—while scattered balls entangled in the mud and perhaps carried down by eddies arising from cavities in the floor, were scattered through all depths—more of it from its buoyancy was floated upwards to the surface—The whole must have been reduced to powder, the teeth dislodged from their sockets and the processes of the bones struck off in the supposition of a long continued agitation of the mass—

Diluvium—Subsidence

[142]

It further appears that it subsided by degrees in proportion as the liquid in which the clay and gravel were suspended escaped thro the bottom of the cavern—the large masses of rock and heavier bones naturally sunk undermost, (just as they are found)—Marks of its gradual subsidence before the

† Plus d'une fois nous avons recueilli des portions de têtes d'ours et [139] d'Hyène qui contenaient tantot un calcaneum, tantot un astragali, tantot un os du metacarpe, du metatarse, ou bien un phalange—Cela ne peut-il pas servir à prouver qu'une cause violente a comble ces cavernes, qu'en un instant tout y a été enseveli? Page 108. Par 2—Schmerling—

|| En effet j'ai reconnu au Fond de Forêt et aux Awirs que les ossemens des [140] petites espèces et nomment ceux des campagnols étant dépourvus de leur chair ont flotté sur l'eau qui alors baignait le sol de ces cavernes. Ces petits corps flottant sur leur surface ont été attirés par les parois de ces antres et l'eau s'est retirée graduellement; de sorte que peu à peu ces os se sont accumulés entourés de peu de limon dans les endroits qui forment les limites laterales de ces cavernes (103 P.)

§ I will not insist on the recovery of teeth in different chambers belonging to the same jaw as they might have dropped out on the way as they were carried about in the Hyænas mouth—but the fact is too curious not to be noted—It alludes to two tusks of a Bear of such peculiar form and stained in so remarkable a manner that they differ from the hundreds hitherto found and evidently belonged to the same individual.

stalagmite had yet acquired consistence may be traced on the sides of the cavern like tide marks.†

And even after the commencement of the crust, the mass underwent further absorption, (I do not mean the change of level it suffered in the Region of the Bears den which was caused at no very remote period by the yielding of its support). It shrank partially away in several places of the Sloping Chamber, leaving cavities between it and the crust; the fossils and stones so deserted retaining a coat of slime precisely like rocks left uncovered in dry seasons—The surface itself was generally hardened into a paste composed of the finest sand and clay intermixed—

[144] *Account for the Absence of Marine exuvie*

It will be inquired how it came to pass that the offscourings of the district are alone found within the Cave. In the supposition of a fluid in movement that could carry such a body of mud into the cavern, it must have necessarily mixed with the adjacent sea and consequently included in its sediment marine no less than terrestrial remains—

This objection would have force, if it could be shewn that the waters of the ocean had risen to the level of the cavern before it was filled with the materials of the plains—

The contrary seems to have been the case—The Land fluid descended from the mountains to the level of the ocean—(and if its direction may be inferred from its gravel, it indicates that it came from Dartmoor)—

It can be conceived how the cavern and open fissures *may* have been filled with a muddy sediment derived from the surrounding surface, by supposing its vehicle to descend from above in the form of rain, and to have washed into the open cavities the moveable substances which it met in its march—

All this might have happened before the Land flood had joined its waters to the ocean—and before the ocean had risen to the level of the cavern—

The absence of marine exuvie in the gravel of the plains no less than in that of caverns supports this view.‡

Proof that it was no ordinary rising of ocean or streams

It is certain the cavern was neither excavated by the ero-

† Dans ces localités (viz. dans les cavernes de Liège) j'ai pu me convaincre et à l'evidence que l'eau y avait séjourné et y avait déposé dans un état de calme ces débris.

Si comme je le pense une éruption violente des eaux a d'abord amené le diluvium dans ces cavernes, une époque de tranquillité a succédé au grand orage de ces deluges.—et l'eau s'est retirée graduellement.

‡ Neither are there marine exuvie in the depot of bones in Auvergne.

sion nor filled with the deposits either of the sea or running waters, of the latter there are none passing through or near it—and as to the former, the cavern no where presents its sides to it—further it is elevated above it at a height which could not be reached by it by the action of ordinary causes and is about a quarter of a league distant from the nearest point.

Sufficiency of the inlets for the mud

[146]

It has been objected that the mouths are insufficient for the admission of such a quantity of mud—but it is not attempted to be shewn by the persons who make this objection that it was derived from the cavern—It is admitted that it came from without—

It should be borne in mind that in their natural state, before the addition of the mould as a guard against the entry of cattle the apertures were wide and broad—and they seem to have been amply large for the {inlet} {immission} of the mud, when it is recollected that it entered in a {liquid} {fluid} state and that according as it poured in, it was swallowed up in the gulph within. Had the floor at the time been on a level with the mouth, it is clear that the fluid would have deposited its sediment against the opposing wall and speedily choked up access to the rest of the cavern—but it was ascertained in the course of our excavations that before the accession of the mud, the basin of the cavern was of vast capacity—The actual surface conveys no just notion of its {original} [145] {former} {virgin} state. It goes on expanding the lower we descend, growing wider and wider downwards conformably to the extended base of the hill which may be regarded as merely its outward crust. Even at present raised as the level is, the [146] floor descends rapidly at a short distance from the mouths—

The fluid therefore instead of lodging its contents against the sides opposite the entrances, as it would do, were it to enter in the present condition of the cavern, was then lost if I might so express it in the abysses below, as it rushed in wave after wave—

But it seems most probable that the ancient apertures were not confined to the actual inlets. It has been already remarked that the sewer like passages which traverse the body of the deposit, as well as the sallyports, appear to have once opened in the sides—(a strong current of air circulates thro them)—though we have not yet succeeded in discovering their {exits} {vomitories,} owing to the accumulation of rubble or their being masked by the growth of copsewood.—

[147] To the question how the cavern was originally formed it may be answered that without denying the action of elastic gases or igneous action as indicated by the presence of Trap—a conjecture may be hazarded that it assumed its present form from the junction of two opposite masses thrown together, whose lower extremities receded from each other as their summits met—the vacuum so produced becoming the cavern—The observations made by the learned engineer just cited seems to countenance this view—He further adds that the presence of stalactites and stalagmites in caverns of any extent is a certain indication that they owe their origin to the convulsions of the soil—"La présence des stalactites et des stalagmites dans les cavernes un peu étendues est un indice certain que leur mode de formation se rapporte aux commotions du sol."

The direction of the Stalactites in Kents Hole favours this hypothesis—for they are most abundant along the presumed line of contact and union of the strata at the roof—and are nearly *{altogether}* *{wholly}* wanting at the sides.—and it seems not improbable that it was by their accumulation that the vertical seam or rent was filled up. The longitudinal figure of the ridge still further favours this conjecture—Schmerling attributes this formation to the same cause, "La formation des cavernes me paraît plutôt être due aux redressements des couches calcaires." Page 13.†

Neither is there any indication of its having been, I will not say excavated, but even altered by the hand of man—It appears to be in the state, into which it was thrown at the epoch of the disturbance of the district by Trap and whatever subsequent modification it underwent at the epoch of the influx of the mud into its womb.‡

Boars remains

We cannot dismiss the subject of the calcareous covering without making some observations on its condition and age—they are offered rather as conjectures than positive conclusions respecting the latter especially—

It has been stated that owing to the exposure of the open chambers, the floor was liable during the formation of its crust to the accession of foreign substances which in course of time were incrustated in it and made a part of it—That particular description of stalagmite cannot serve as a criterion of its age but it has been seen that in retired situations it was pure from all extraneous matter and that upon it a

† [Op. cit. W.P.]

‡ [Pages 148, 149, 150, 151, 152, 153, are missing. W.P.]

judgment might be founded of its age—At the entrance of the corrydor it has been shown that the stalagmite was composed of a pure precipitate of calcareous matter, except half down, where it was divided into equal halves by a thin horizontal seam of animal and vegetable matter—from its first commencement this was the only substance that it received, nor did it meet with any other until it reached an equal thickness above it, that is, till the cavern becoming much frequented its progress was arrested by visitors—In fine it appears that the floor was not trodden from the period that it commenced forming up to that when the above stratum of Boars remains and charcoal were spread out on its surface—and it is equally certain from the absence of all foreign matter in the layer above it that from the time of its deposition up to a comparatively modern date this part of the cavern remained unvisited—

The modern period, when the cavern came to be frequented is marked by the cessation of the crust and the deposition {over} {upon} it of a {layer of} {coating of dark} mould—but should it be closed and all access prohibited, the dro[p]† would resume its process and quietly create a la[y]er of‡ stalagmite similar to those below it—

What then are we to infer from the presence of this seam [156] that cuts the stalagmite in two? That when the crust had attained half its depth it was interrupted by the visits of the savage whose spear was found in a grotto [in] the upper gallery along with the remaining corresponding portions of the Boars skull accompanied by the head of a Badger—one of whose under jaws is fig.§ and was found in the seam—and that after he ceased his visits to the cavern the process of infiltration resumed its work in continuing the stalagmite to its present height—

It is a curious inquiry to ascertain at what historic period the cavern was visited by the Boar hunter armed with his iron spear.¶ Could we arrive at an approximation to that period, by doubling it we might have the age of the stalagmite—An intermediate period between the epoch of the de-

† [Small portions of two lines of the MS. have been here torn off. W.P.]

‡ [The page numbered 156 is on the opposite side of the same leaf as that numbered 154. W.P.]

§ [Fig. 13, Pl. E, in "Cavern Researches" is that of the right ramus of the lower jaw of the Badger. W.P.]

¶ The remains of the Boar are commonly found in Peat. A fine under jaw with tusks was brought me. Are they not sometimes found with the Irish Elk the period of the existence [of] which was indicated by the discovery of a man with cleak [P] ? and in London ?

position of the mud and the present time is strongly indicated—which squares with that assigned by history for the occupation of this country by its savage aborigines which dwelt in native caverns and pits which they dug under ground, before they formed into societies and built themselves abodes on the surface, brought fields into cultivation and assumed a civilized form—

If we may compute by this scale, taking the charcoal seam as a species of chronometer to measure the time elapsed before and since its deposition, we shall have pretty nearly the time which should elapse since the Deluge—viz four or five thousand years—so that this cavern may be said to furnish not only evidence of the fact but also of the epoch of that event—(its chronology)

[END OF FASCICULUS A.]

[FASCICULUS B.]

SITE—SURFACE

[11]†

THE entire body of the Limestone is either traversed by deep {fissures} {chasms,} or perforated with caverns—within an area of a few miles circumference the caves of Barton, Anstis Cove, Kents Hole and Berryhead occur;—besides numerous cavities of minor {interest} {note}—the principal of these natural cavities stands half way up the acclivity of a ridge which constitutes the south east flank of the vale of Ilam—the fronting and elevated Terrace hills which overlook it exhibit gently undulated inequalities of surface—The sides of the bases are abrupt and precipitous—detached masses overhang the entrances of Kents Cave and are strewed around its base—On a late occasion the wood which cloathed the cliff was partially cleared away, the rock presented bare bleached and corroded surfaces. There was no large rent or external chasm observable in its summit—The only visible opening excepting the two mouths is thro the cleft which forms and extends inwardly from the southern mouth, merely sufficiently however to admit the fibres of the shrubs that are seated in the hollow surface of the rock, to insinuate themselves into the interior (where they are found buried in the mud, or firmly embraced between the laminæ of stalagmite—)

In the hollows of the rock there still may be traced vestiges of the red soil analogous to what covers the floor of the cavern below and the plains around—but vegetable is most abundant—It has been generally washed away by rain except where vegetables have fixed and protected it—

Mouths

[13]

Kents cave lies about a mile S.E. of Torquay and only a few perches to the left of the turnpike of the n[ew] Teignmouth road—A winding ascent through a copse up the skirts of the cliff conducts directly in front of the cavern—It has two mouths which are nearly on a level, {separated by an interval of a dozen yards} {at the distance of a dozen yards.} You descend the whole way, and still more rapidly ascend

† [The first ten pages appear to have been torn off. W.P.]

from the road over rugged * * * * and climbing over a stout style raised over the remains of an ancient aqueduct—you wind round the skirt of the hill—

Arched Mouth

The mouth that on the left looks East forms, by the curving of the rock in the form of a horizontal arch—viewed from the inside it displays a bolder curve, the strata bending above each other in a series of planes which however towards the south extremities spread out an oblique angle to the horizon. The entrance was originally much deeper—on clearing away the rubbish, which was heaped as a fence against the entry of cattle it was ascertained to be—the floor solid rock, worn, and slightly polished—it retained no vestige of the materials in the interior. In its natural state the passage was ample for the passage of an ox, it admitted immediately into the body of the cave, and threw a considerable light into this branch of it. The portion now admitted reaches no further than the edges—The remainder of the cavern is involved in total darkness—like the grotto of Posilipo—which Seneca describes “*nihil illis faucibus obscurius quæ nobis præstant, non ut per tenebras videamus, sed ut ipsas*” darkness too deep to be dispelled by the glare of a few torches.†

[12]

Opening the left Entrance.

The outside of the left entrance was cleared away by the directions of Mr Northmore—a solid floor was found about four or five feet below the surface—it had no remarkable character—was simply corroded—rather polished—but considerably less so than the summit of the hill—the substance which was removed consisted of animal and vegetable mould mixed with red marl stones and stalactites and such other adventitious matter—it would seem to have been deposited there to prevent the entrance of cattle—I was present at the opening of the mouth—there was no trace of the red sediment of the inside having been probably washed away by rains if it ever existed there—but I am rather disposed to believe that it was purposely removed at the time that the inside of the mouth was excavated—This was about 3 years after I had opened under my own eye and partly with my own hands—many cartloads of similar loose stuff to the outward filling only that modern bones, pottery, slate, pebbles and shells were abundantly intermixed with it and were

† [Seneca's “*Epistles.*” Epist. lvii. W.P.]

heaved away before I could find any intelligence of the bottom—about five feet below the surface, but 10 feet below the interior floor, a chasm opened under our feet, it extended nearly across, i.e., about 6 feet, which communicated with a sewer like cavity running parallel with the mouth. A large ledge of fallen rock stretched over it like a lid and divided it from the loose layer above—the rocky sides sunk down almost perpendicularly like the side of a bason—and defeated all our labour to ascertain the original bottom—it was covered over with a bright red and pure sandy marl, interspersed with small splinters of bone—various teeth in all respects conformable to the grand deposit in the interior of which hereafter. We made repeated efforts not without risk, with suspended rocks from the roof of the chasm threatening to lose their cohesion—to pierce through the red stuff to the fixed rock—and had boldly penetrated far down into the chasm, when a cross ledge forbade further descent—The place is left open for inspection—We however gained one point of interest by ascertaining the amplitude of the original mouth—it may be perceived running under the walls, from which it is divided only by the space of a few inches—The chasm was formed by the absorption of the sediment by lower cavities down which the finer particles were conveyed by water—this chasm or fissure is not more than 4 feet wide pretty uniform in breadth—and running parallel to the wall and intersected as will appear by transverse fissures. The mouth of it near the entrance was formerly open until this excavation of the former filled it up as described—Thro it animals found access to the body of the deposit, and used it as a thoroughfare—for the bones of modern animals lay strewn over its entire line—

Cleft Mouth.

[13]

The aperture on the right is at present the ordinary and more accessible entrance—It is simply a cleft in the rock of a triangular form—its present dimensions preclude the advance of more than one person at a time and that till lately in a stooping posture—The floor of this entry had also been considerably raised above its primitive level—the ground was pierced 6 feet below the present surface without reaching the rock—The covering of the floor in this passage is modern mould superinduced over the ancient deposit containing fossil bones which will be more fully specified—Before the addition of these substances, this mouth also was capacious and afforded easy access to the interior but still inferior to the other entrance—

- [14] A lobby like alley stretches thence in a straight line into a small grotto measuring from the mouth to the wall 43 [feet] two low and narrow recesses pierce the right side wall like ovens—Thro the interstices in the rock at this point, the roots of shrubs and plants gained access and successively perishing resolved into black vegetable mould which was further augmented by the dung and skeletons of rodentia and the dead shells of the * * * which retired hither to hybernate—The calcareous fluid falling on these adventitious substances as they successively entered sealed them down which in progress of time formed a singular acervation of alternate plants and spar—With these accumulations of animal and vegetable mould resting on a lower deposit of mud the side recesses are nearly choked—Just sufficient was removed to show that these alcoves once opened into a group of cavities beyond, which were in the course of digging broken into from below—now known under the designation of the “Wolf’s Cave.”

The main path proceeds to the left over fallen ledges of rock beyond which it bifurcates—The body of the cave is traversed by a central partition of rock which commencing from the sloping chamber whose southern flank it forms stretches thro the centre of the cave to its termination—bisecting it into 2 nearly parallel grand divisions.

Holding its course along the elevated edge of the left wall on the eastern side it leaves the sloping chamber on its right—and runs in a line with the arched entrance which it passes thro a series of vaults which will be considered collectively under the appellation of the Superior Division—from the wall at the entrance to the end of the suite the measurement is 230 feet.

It takes a second direction—after passing the ledge just noticed the route deflects to the right and descends rapidly into a capacious vault—whence it penetrates thro a long narrow defile of rock on the west side and terminates in the cul de sac, measuring from the entrance grotto 370 feet—turning off suddenly to the left by the oven it tends towards the East side with which it does not communicate [and] conducts to the water—the total length is 564 [feet]† Including the Idol Cave situated on the north of the dome, the aggregate length will exceed 700.

- [16] Adopting this natural arrangement we shall proceed to describe each Division separately in the order we have just traced it.

† [Part of the leaf torn off here. W.P.]

Superior Division.

The upper section on the East side is elevated 20 ft above the lower—It consists of a succession of coved vaults unfolding successively each into another with all the regularity of a suite of arches hewn out by the hand of art—

The first of the system extends to the depression in the level of the roof and floor at the point of central excavation—measures 76 feet—thence to the projecting ridge half-way across denominated the Abbots Chair 46 ft—and to the Druids altar at the end—40 ft—

The breadth varies from 30 to 70 ft—measured across at the mouth the diameter is 60 ft—it averages 30 ft in height—

About half way down this long saloon about 12 yards below the mouth two long and narrow tunnel shaped holes pierce thro the base of the left wall into the external skirt of the hill in the face of which their embouchures appear to have once opened like mouths or sallyports through the *** concealed by the thick skreen of wood on the sides.

They are 40 ft distant from each other—

That nearest the mouth is accessible for 14 yards beyond which the encrustations of the sides contract the passage to a point.

The lower one at the end of 80 ft suddenly bifurcates—the right branch after suffering compression into a narrow neck, expands into an ample cavity enclosed at the nearest side by pillars of stalactite—The interior displays a variety of brilliant spars and transpt. figures—The other shoot wanders to an unexplored extent.

These perforations run nearly horizontally, parallel to each other and at right angles with the Saloon—

The upper one obliges you to proceed on hands and knees—the lower dilates and contracts from 4 to 18 ft, dips under the side walls, in some places you may stand upright

Hence it appears that the cavern consists of a system of [17] two main trunks or great streets with lateral branches or allies of various dimensions—and these again communicating with an infinity of minor ramifications too narrow for investigation—

Floor of Superior Division.

[18]

The floor of this long gallery displays a scene of the greatest disorder. Masses piled upon masses in the centre obstruct the passage at every step—according as they happened to scale off successively from the roof,—some of these slabs are * * * by * * * and of equal dimensions with the

overhanging vault, whose ceiling they {once} {anciently} formed—their under surfaces are still studded with pendant stalactites—The droppings from the roof have cemented the whole into a compact mass. There is still a tendency in the strata of this division to exfoliate plate after plate—Half detached laminæ daily threaten to swell the pile—at the sides the huge masses are heaved up compactly with apparent order. It is not improbable that the ancient inhabitants of the cave removed them out of their way—some of these rocks weighing many tons are jammed in nooks where art alone could have placed them—and at a distance from the scene of disorder—This process of disintegration has exposed the left side of the cave and displayed the inflexions in one place and horizontal disposition in another of the strata which assumes all possible inclinations—The opposite side offers a curious contrast in the massy incrustations on its surface—on entering this division the right flank is worthy of attention loaded with massy concretions of tufa that depend from the roof at regular intervals like inverted cones in a Gothic skreen—and further in the interior marble like folds of drapery project from the walls—curiously streaked with red oxyde of iron—Lac Lunæ and other modifications of the * * * may be observed on the roofs and sides—at the close of the saloon the process of infiltration is in full activity, it may be seen unceasingly raining on a mound of its own formation which it is insensibly raising to a junction with the roof—

I should not omit in this place to notice a low crypt like recess nearly opposite the mouth where relics of art were found concealed—the roof of this cell is hung with papillæ of exquisite beauty—its mouth being nearly closed up has protected it from mutilation. The tunnel shaped perforations on the opposite side are cased over with a wainscoat of spar—

[20]

Inferior Division

The inferior Division takes its rise from the base of the sloping chamber—Before we undertake to {describe} {follow} its course it is fit to describe the large apartment which serves as a vestibule to the two main sections—it is 60 feet in advance of the ordinary entrance—its diameter of its area 70 ft by 30—and graduating from 10 to 36 feet in height. The overarching vault displays its fullest expansion in this cave—it is richly hung with gorgeous groups of spar, many of which are so strikingly like the heavy pendants of Gothic arches that the association forcibly presents itself to the mind—The idea of the latter may have been originally suggested

by these water-fretted vaultings—The roof is pierced with numerous spiral holes, which served as spouts to transmit the collected fluid of the surrounding crevices, the edges of which are {bordered} {encircled} with clusters of stalactites, severally distinguished by visitors as chandeliers and lustres—The effect of the whole when illuminated recalls the description of caves of ice in the north when pierced with the sun's rays—but much of its natural embellishments have been appropriated to the decoration of artificial grottos, in this respect following the fate of the ornaments of Wokey hole which transferred to the grotto at Twickenham.

Previously to these illjudged mutilations columns of spar connected the roof and floor and appeared to support the broad arch of this sepulchre—In several places there still exist those mamillated eminences and cones known as cows paps and {blocks} {mounts} of alabaster—produced by the concentrated droppings on the floor they afterwards served as the centres or nuclei of the radiating circles of stalagmite which with increase of the fluid went on spreading wider and wider till it embraced the extreme edge of the area, at which point it is thinnest—

It continues to ooze thro the sides from which it projects in [22] the form of cascades congealed in the act of gushing—These lateral exudations generally flow across the course of the vertical depositions layers of which are easily distinguishable and separable from the circular ones with which they alternate—where there is an inclination in the floor as in this chamber which slopes rapidly—the vertical drop running thro porous masses continuing to deposit them, follows the depression of the area without the matter it holds in solution stagnating into cones, (never rise to any magnitude except only in levels) and uniting with the lateral forms a homogeneous crust—

The pavement of this sloping vault is thus the joint produce of these confluent currents, the precipitous descent of its floor having brought both into contact and concurrent action. In their progress they glazed over every casual substance of all periods lying in their course hence the semblance of the surface to a mass of congealed water frozen in its descent over the opposing rocks—

The same agent which in its progress imparted such singular beauty to the interior of these gloomy vaults appears to have been destined to {perform} {fulfil} a more important part. It has spread a durable cement over fragile and perishable substances and as if embalmed them against decay by

sealing against the access of air and masked against casual injury what must have otherwise in a few years have resolved into dust,—and after a long lapse of time thro which few other monuments have been able to endure, this cave has succeeded in transmitting documents appertaining to each epoch before and since the commencement of its operation [24] and at this late hour has delivered to the day under a new order of things with all their original characters fresh and almost as undefaced as at the period when they were first inhumed—

Inferior Division—Arcade

A long straight and horizontal alley not unlike an arcade—branches off from the lowest level of the sloping chamber. About two thirds of the way in and after suffering an alteration in its area to the level of the innermost vaults, towards its termination ushers into the cul de sac.

Throughout its course it throws off numerous ramifications that penetrate into the rocky sides. The left flank of the passage is naked—the opposite swells out with stained abutments of spar—The surface is very unequally divided into numerous troughs enclosed with upright walls of a foot high and more—which during the prevalence of rain served as reservoirs of pellucid water—but in dry weather they are empty. The splash of the drop impels the stony solution in circles towards the sides (to the edges) except when impeded by the nature of the level—when it insensibly rises, layer upon layer, into wavy enclosures of paste like the standing walls of pie crust. In less frequented vaults which escaped unobserved and therefore unmolested, the forms the infiltrations assume are exceedingly picturesque—walls surmounted by capitals and spreading ornaments, cisterns, capitals, idols, &c

This division assumes the form of a cross—the arcade serves as the tree the cul de sac and the bears Den its arms—& the Bears den on one side and the elongated ledge on the other as its arms—

The cul de sac is closed in front by solid rock—but to the right it is prolonged over a steep ledge beyond which it gradually contracts to a point where it takes its appellation of the cul de sac—Measured by its longest diameter in this direction it over 100 ft. by 34—Enormous cones of spar, the largest in the cave rise in pyramids from the floor surrounded by rocky masses heaped on each other in great disorder and large flags of stalagmite which at a remote period were torn up reversed.

The sides are curiously overlaid with red coloured incrustations and crowned with singular cornices and stucco.

An extensive suite of cavities is situated on the left of the cul de sac—the approach to which is thro a low aperture in the overhanging curtain of rock—a few paces beyond which the path rises 3 feet over a platform of stalagmite carried over irregular rocks and introduces you into an elongated strait-like passage 130 ft. long, through which you proceed in single file by screwing your body with difficulty into the narrowest compass—This passage is termed “the oven”—It sounds and resounds under the foot hollow the whole way and in fact is nothing more than a fragile bridge of stalagmite, lying over the vacuum occasioned by the subsidence of the earth into lower cavities—it is at right angles with the cul de sac. The [26] oven opens into the Bears cave so called from the predominance of the remains of that animal there.

Zig Zag Rout

There is another approach to the Bears den, not less arduous however by which the narrow pass of the oven may be avoided by turning abruptly away to the left near the steps hewn in the elevated platform of stalagmite—the rout lies thro scattered rocks and under hanging crags—after pursuing a zig zag angular {course} {ascent} thro a suite of bold and awful vaults—you come out near the extreme orifice of the oven in the Bears cave, extends 90 feet in length—Both avenues tho widely separated at their entrance rapidly approximate towards their close and finally converge to a point, describing in their confluence a triangular area—

Thro the entire range of the oblique rout the passage threads thro a labyrinth of pendent pinnacles descending nearly to the ground thro which like interweaving arches the path winds, sinking and ascending in its course. Long exposure to the air and percolation of water thro the body of the rock have wasted all the more soluble particles and left only the skeletons suspended in air with their veins and organic contents in relief holding the rock together perforated throughout into a thousand cells and cavities—In progress of time the corroded mass loses its tenacity separates from the sounder—and tumbles on the floor where the further advance of decay is arrested by an investment of stalag^{ta}. Such is the mouldering condition and fate of all those portions of the shell of the cave which are unprotected by incrustation—and it is rather curious that the left flank of almost all the passages is naked and worn carious while the opposite sides

are richly cloathed with stalactites and uninjured and solid in their parts—

[28]

Undervaultings in Zig Zag

About the middle of the rocky path a long and close horizontal perforation pierces to a considerable extent the side—it is in all respects like the oven just described except that its further extremity is closed by an accumulation of spar—Here also are spiral pits in the face of the rocky floor 8 and 10 feet deep which you descend by resting the arms against the sides and fixing the feet in the crevices of the rock—you alight in a low range of undervaultings or second cave, to which the floor of the upper cave serves as a ceiling—In some places you can stand nearly erect—but the space does not generally exceed two feet in height—The eye may [be] able to follow with its range for fifty feet on all sides, beyond a few yards it is impervious to search—There is no question that they join those which we shall presently point out in the adjacent Bears den—

The ceiling consists [of] the under surface of the crust overhead—the floor a disturbed stratum of red mud partly covered with broken flags of stalagmite, partly discolored by a dingy film produced by the moisture of the air—

Bears Den

The Bears cave is an oblong apartment into which the rock descends half way in the form of arches—formerly the stalactites suspended from which rested on corresponding cones on the floor which was encumbered with fallen masses heaped irregularly—At its furthest extremities it gives off two branches—That on the left hand contains a pool of water in the hollow of the floor of an average depth of five feet, and 16 feet by 8 in diameter. A few yards beyond the water the rocks bends over and forms the extreme boundary of the cave—from which point to the opposite entrance at the orifice of the oven the length is about 70 ft.—more ?

[30]

The other branch runs parallel with the right wall into an elongated lane bifurcating into tube shaped off shoots which range under the southern skirt of the hill till they are lost in darkness One of them may be followed for 100 ft. the whole way so narrow as not to allow turning round. In this remote region there are numerous tortuous spiracles or shafts in the floor down which you wind into a nest of cellars exhibiting all the characters of those just described as existing in the oblique rout, but these are more ample and lofty and

accessible. They range to a great depth beneath the walls of the cave and give to it a degree of amplitude and interest of which a survey of the upper area can convey no estimate. The summit of the hill covers an area of * * * which corresponds with the size of open space within now remaining—which is simply the upper region of the shell—The cavern appears to have been coextensive with the expansion of its base, nay even it may have entered into the adjacent rock.

In the course of excavation it has been ascertained from an examination of vertical clefts in the floor that the basin is at least 60 feet deeper than the existing level—previous to the afflux of the mud, and addition of stalagmite and fallen rocks, it was one profound reservoir or repository—almost in every case we have dug under the side walls and the longitudinal partition in the centre and traced the mud beneath their bases—it appears therefore that previous to the elevation of the floor by the adventitious substances just enumerated, there was an uninterrupted range at least thro the principal branches of the cave, unimpeded by most of the intersecting partition and limits which rocks that rest merely on the surfaces of the deposit at present occasion. These rocks hang half way into the vacuum, but by the elevation of the floor they rest upon it and occasion the present division. We have also seen that the mouths in their natural state are of ample capacity and afforded facility of access to the interior whether for animals passing to and fro—or for the admission of the mud deposited in its cavity—

It is also perhaps not less certain that the deep perforations under the skirts of the hill, tho now inaccessible from within to their fullest extent from the accumulation of mud and spar, and not at present discernible in the face of the cliff, are at present disguised by vegetable mould and brushwood—formerly served as entrances.

The vestiges of burrowing animals which find their way daily through these sallyports leaves no doubt of their original destination and use—In confirmation of this view I might add that hillocks of red mould easily recognizable as the mud of the cave may be traced round the edges of holes in the side of the hill from which it is daily forced out by rabbits and foxes in their return to the surface.

Red color and ferruginous character of the Stalagmite and diluvium. [31]

The stalagmite is harder, brittle and more stratified in this range—and it as well as the substances it covers are deep

stained of a reddish brown color—The iron which so largely impregnates the rock became by the permeation of water oxydated and held in solution combined with the sulphate of lime which it tinged, fell and first saturating the mud and mineralizing the bones, in progression of time contributed to form the crust above them—†

[36]

Inscriptions of the several Chambers &c—

It appears the most natural and perhaps most interesting plan to describe the appearances and record the discoveries in the order they disclosed themselves whether on the surface or in the bosom of the cave.

Innumerable inscriptions crowded one upon the other are engraved upon the vaulting and floor of stalagmite—and attest its celebrity as a place of resort—They are carved in divers characters, Greek, Romoman and German and embellished frequently with grotesque devices—In the more ancient the dates are expressed by letters M. D. V.—They may be traced thro the last three centuries at least down to the present time—and exhibit curious examples of the oblique course and insensible effects of incrustation—In some only a letter or syllable, in others the entire inscription is glazed over by a transparent membrane thro which it is still legible, the fluid having followed and partially filled up the indentations of the characters but not totally disguised them.

In other specimens a letter or word is overlaid by a thick film, and quite obliterated—the remaining members escaped by lying out of the current of the drop—where the droppings precipitated into a soft cellular deposit the inscriptions soon recede before its rapid advances—This is the case in the grotto near the common entrance and in the skreen at the opening of the superior division—In the lobby there survive however dates from 1624 to 1782—

[38]

In the arcade the coating of the walls exhibits all the firmness and polish of marble—Being slowly invested they retain longer the impressions committed to it—The same remark is applicable to the cul de sac to which it directly conducts—At the entrance of the arcade there is a Greek inscription and along the line of the arcade there are numerous names and ancient dates distinctly visible.

† [Pages 33, 34, and 35 are blank. W.P.]

Cul de sac.

In the front wall fronting you in the cul de sac we read :—

Peter Lemaine	John Martyn	In German characters
Rich ^d . Calley	1619	Ambrose Lane
of London		Mildred
1615		Torkington
		{ Device sur by  Dome mounted a cross }

and on a huge cone of stalagmite on right of the entrance there is a remarkable entry—

Robert Hodges†
of Ireland
Feb. 20
1688

the letters are glazed over—and partly effaced.

The Chancellor Bacon is recorded among those who visited [40] this cave, upon what authority it is asserted I cannot ascertain. This circumstance is not related in his works. As there is little doubt that this cave contains records anterior to those enumerated—tho they have ceased to be visible, or rather difficult to be deciphered—the indistinct traces still remain—From the vicinity of the Tor abbey, which was founded under the reign of John—and of its more adjacent dependency of Ilsam it is probable that this cave was visited by their inmates.

Articles on the Surface

[42]

Iron Spearhead.

The cave was always before the commencement of Excavating open to the public—The crowds of visitors who from the earliest period were prompted by curiosity to explore it would naturally carry away with them as a memorial of their enterprize any interesting relic that lay exposed on the surface—none therefore were to be expected and now found in the more frequented chambers—but in the lateral recesses which were unknown or impracticable to casual adventurers some curious specimens were found strewed over the surface—Omitting the remains of Sheep, Dog, rabbit and Fox and pieces of iron and copper all more or less encrusted that lie

† [It really is "Hedges." W.P.]

about in secluded corners and niches in almost every part of the cave, we pass to the interesting little grotto opposite the lower mouth situated in the upper division—it is formed by the bending over of a flag of stalagmite into an arch, elevated only two or 3 ft above the level of the floor—the mouth was closed up with a blackish mould—In digging which, while in quest of pottery we broke into a circular cell—The aperture is scarcely sufficiently ample to admit a person lying on his breast—the space inside the circumference of a few feet—The floor was covered with stalagmite—in the surface of which were inserted large * * * shells with the cup uppermost as if placed to collect the dropping. the entire skeleton of an animal resembling Badger portions of the upper jaws of a Hog with one of its tusks indicating great magnitude—in the midst of all a barbed spear of iron—figd. in†

These relics were severally invested with a crust of stalagmite, which still preserved the forms of the specimens like the articles from the German and English dropping wells, and reposed with their under surfaces inlaid in the floor—

Its vicinity to the mouth, its secrecy, incline us to the opinion that it was used as a place of refuge or ambush, from which its tenant sallied forth in chace of game.

- [44] The wild Boar continues to be hunted with the spear—the large animal some of whose remains are preserved here may have fallen by the spear which lay near it—many of the bones when stripped of their spar were found discolored as if by smoke—pieces of charcoal indicated the remains of a fire—

The lowness of the roof and the depth of the crust beneath prevented further search into the heart of this cell—

As these substances lay uppermost on the surface we judged it right to commence with them—Unwilling to anticipate the order of excavating we forbear in this place to shew that they claim a higher antiquity than many substances that lie huddled about at a greater depth—and that connect themselves with similar deposits of Bores bones of a remote date in the adjoining saloon and other branches—

- [46] The rocks along the entire tract from the ordinary entrance to the termination of the superior Division including the sloping chamber conceal relics of different periods—lying between and under them appears a fine blackish mould abounding in quantities of broken pottery, charcoal, ashes and discolored bones—near which clusters of pipeshaped stalactites or icicles such as hang from the circumjacent roof, were remarked as carefully collected in numerous places round the

† [This object is not figured in any plate known to me. W.P.]

edge of charcoal—Lumps of virgin copper ore lay near nests of muscle and * * * shells—rock after [rock] discloses the same appearances—contiguous to the 2d mouth nests of the scales of beetles.

Near the upper mouth a pit was found hollowed out in the stalagmite, sealed over at top with a thin pellicle of spar—beneath which there was discovered a singular assemblage of broken pottery reddish colored and calcined bones, a collection of shells and a curious ornament of bone—in shape not unlike a scissors case, pointed at one end notched like a comb at the other—See plate * * * fig * * † The whole appeared to have been repeatedly disturbed—fragments of former crusts occurred intermixed with the relics—the pottery was broken and the matters that most probably had been inclosed in it were scattered loosely about—

Near the verge of the pit a large quantity of the same description of pottery was buried in a brown pulverulent earth overlaid by a skin of stalagmite supporting a layer of modern mould—among the pottery were dispersed a number of oval-shaped pebbles of sandstone limestone and chert, seemingly formed and polished by art—copper nails various species of Lacustrian and marine shells the palate of a fish of the * * * the surface of which is studded with pearl like [48] tuberosities and a pin of bone retaining at one extremity its articulating joint, but shaped at the other to a tapering point, fig * * †

This bed was about $2\frac{1}{2}$ feet deep—thru which dead interlacing roots were. The whole rested on a second plate of stalagmite about 6 in. thick—which completely divided the substratum from the bed upon it—

At the bottom of the Wiltshire Tumuli cists or basons for the reception of the ashes, ornaments and arms are found—This excavation was cut for a similar purpose.

Pottery.

[47]

The Pottery varies much in quality and style of ornament—there are specimens from the rudest sunbaked to the finest lathe-turned

The former consists [of] a coarse soft earth, generally half in. in diameter, compounded of kneaded up particles of rubble and black mould—which were not consolidated nor converted in the process of drying—very fragile—A rude zig zag moulding or notching runs round the edges—see fig * * †

† [Not figured in any plate known to me. W. P.]

It precisely agrees in the character of the material and the rude indentations of its surface with the earthen vases found in the Wiltshire Barrows with which I have compared it—

The other description of pottery is composed of a fine compact earth, turned on a wheel as the circles round its surface indicate—and firebaked from its approach to the redness of brick—the centre however not penetrated by the heat is dark. The moulding is of various tasteful devices, like the mouldings of anc^t Etruscan vases imprinted evidently with a rolling instrument like that used in bookbinding to indent the vellum—The fragments of sepulchral urns and cinerary cists of superior art evidencing a posterior epoch—

These two potteries appear to be quite distinct and to belong to distinct periods. Sir R. C. H[oare], Mr Cunningham of Heytesbury and Miles found two separate interments effected at distinct intervals†—exhibiting analogous characters

In the upper was Roman pottery, instruments of military and domestic life—The under characterized by the presence of calcined bones, ruder arms, flint arrow and lanceheads—

The Rev. L. Welland has indulged me with the inspection of one of the urns raised by Mr. Miles from the great tumulus of * * * * The pottery cannot be distinguished from that of the cavern—the contents of the urn remained in the state it was found—In the presence of Mr W. and Dr Olinthus Gregory and Party I emptied out the urn—it was found to contain as I predicted—

[48]

Human bones

The contents of this bed suddenly changed from the preceding—a Hyænas tooth first met my Eye—then one of horse, another of large Deer and the jaw of a Fox adhering by mud to a bony splinter—In the midst of these I beheld a profusion of small chippings of flint, with a few well formed arrowheads and blades—my astonishment could not be exceeded except by the perplexity into which the scene threw me—I instantly covered up such of the flints and bones as I had not disturbed in their situation and I desisted for the day—instantly on my return I took up my pen with the determination of announcing the anomalous discovery to Dr Buckland (whom I promised to apprise of the next discovery of flints)—having occasion to inspect one of the fossil bones, the brownish color and unusual characters of the bone struck me as unusual—I suspended my intention to write till after

† [See "Archæologica," vol. xv. pp. 338-46. W. P.]

further investigation—and repaired early next morning to the scene of the previous days.

In enlarging the excavation I fell in with more flints, two or three vertebræ which I was at a loss to determine and at the next blow I knocked out a fragment of a Human cranium and teeth which soon threw light on the vertebræ—

As I advanced, a piece of another skull much slighter than the former and two human teeth belonging to a young individual next caught my attention—

It is as difficult to express as it is to disguise my wonder at these successive anomalous discoveries.

When I had cleared away a level area of a few feet around [50] me, I applied to sinking still deeper into the loam—when behold the ground became suddenly more solid and compact, the flints of which I collected above 60 in the earth above, all at once disappeared—human remains likewise vanished—and fossil bones of quadrupeds prevailed exclusively in the undisturbed regions of the mud—by comparison of the earth upon the Human animal bones of the upper surface with that investing the fossils below there was a manifest difference—specks of charcoal and a brownish veget^a mould appeared blended into an impalpable mass with the firm red loam—which with its fossils was dug up and thrown about among adventitious matter, at the time when the entrance was deepened and enlarged by the people who seated themselves near the mouth, to avail themselves of the advantage of the light, to fabricate their flint knives—

There is a visible difference in weight between the animal and Human bones—the former are heavy and compact—and firmly attached to the tongue, the latter are much lighter, and in appearance approach nearest to grave bones, than which however they are firmer, heavier and better preserved—

Cause of discovery

This important discovery may be traced to my distrust of the statement of the laborers employed in sinking the door posts of the entrance—They stoutly asserted that they were forced to sink thro solid rock and endeavor to dissuade me from examining myself the nature of the floor—certainly to all appearance it had all the semblance of a continuous rocky surface—loose {flags} {slabs} thrown over heaps of rubbish to prevent the entry of cattle that gave it this semblance when these were removed, the series of beds presented themselves in the order just described—

If the early visitors adventured so far as the innermost [52]

branches of the inferior division, which is rendered probable by the discovery of charcoal and other memorials of their visits, they tarried there not long—they left no pottery behind in this remote quarter—nor flint relics—all of which seem to be confined to the superior division which by its vicinity to the two mouths that open directly into it invited them to enter and sojourn there—

- [51] *British settlements* or villages were accurately traced by Sir R. H [oare] at Knookdown—where two British towns situated at an inconsi^{ble} distance from each other, yet seemingly connected by Old Ditch over which the subterranean habitations were carried—the site is marked by cavities and inequalities on the surface, in which fragments of rude pottery &c are abundantly discovered—These high grounds were recommended by nature, being less encumbered with wood and affording a better pasture for the flocks and herds from which the primitive erratic tribes or first colonists or nomades drew their subsistence—as well as from hunting, before they descended with Roman civilization into the vales and settled along the banks of rivers.†

Sir Rich^d has also discovered the vestiges of 6 British villages on a Down called Little Cheverell‡—dreary regions the most defective in modern cultivation prove to have been the most fertile in ancient Population—

Sir R. H supposes that the huts or hovels of the A Britons were covered over with a roof of wicker work, or poles interlaced with boughs and overlaid by turf—In Wales a large stone was found perforated in the centre for the reception of a pole to support the roof, is found in the centre of the huts.

Pottery ante and Post Cæsarem

Ante and post Cæsaris tempora ibi fuisse sepulchratum, faciunt vasa hic reperta; quarum alia tenua [?], firma, elegantia, rubentia, pulchra, nitentia, per omnia deniq. figulo Romano digna; alia & diverso, crassa, fragilia, male tornata, colore fusco, surdoque, rudi manu subacto lutu, et solibus recocto [?] potiusquam rotâ formata et fornaci imposita videntur. (Monumenta Kempiana—found in Goodmans fields London)

Druidical Temples

- [52] Along the granite ridge over the moors from Cornwall to * * * There are still visible numerous crags which tradition

† [Ancient History of South Wiltshire. By Sir Richard Colt Hoare, Bart. 1812, p. 84. W.P.] ‡ [Ibid. p. 96. W.P.]

affirms to be Druidical altars—(see Borlase and Jones, Pol-whale—)† The custom of resorting to high places for the act of worshipping is of the highest antiquity, suggested by a very natural notion that the votary thus came into more immediate communion with the Deity “In the book of Kings” (says Sir R. Hoare commenting on this choice) “we are told ‘nevertheless the high places were not taken away for the people offered and burned incense yet in the high places,’‡ upon which passage a modern writer has made the following note (Burder in his oriental customs vol 2. p. 156.) ‘Many of old worshipped upon hills and the tops of high mountains imagining that they thereby obtained a nearer communication with heaven. *Strabo* says that the Persians always performed their worship upon hills. Some nations, instead of an image, worshipped the hill as the Deity. In Japan most of the temples are at this day upon eminences, and often upon the ascent of high mountains, commanding fine views, with groves and rivulets of clear water; for they say, that the Gods are extremely delighted with such high and pleasant spots. This practice in early time was almost universal, and every high mountain was esteemed holy. The people who prosecuted this method of worship enjoyed a soothing infatuation, which flattered the gloom of superstition. The eminences to which they retired, were lonely and silent; and seemed to be happily circumstanced for contemplation and prayer. They who frequented them were raised above the lower world, and fancied that they were brought into the vicinity of the powers of the air and of the Deity who resided in the higher regions. But the chief excellence for which they were frequented was, that they were looked upon as the peculiar places where God delivered his oracles.”§

Resuming Research

[64]

The place {selected} {chosen} for resuming my researches was the spot which yielded the few specimens that in Oct. 1825 first furnished indication of the manifold contents of the cave—This spot is situated about half way down the declivity of the sloping chamber under the right wall—On examination it was perceived by the thinness of the broken plates strewed about that at a very remote period before the

† [See “Historical Views of Devonshire.” In five volumes, by Mr. Pol-whale of Polwhale in Cornwall (1793), vol. i. chap. i. pp. 53, &c. Also “Antiquities of Cornwall,” by William Borlase, LL.D., F.R.S., Rector of Ludgvan, Cornwall (1769), book iii. especially chaps. ii. iii. iv.—W.P.]

‡ [1 Kings, chap. xxii. v. 43. W.P.]

§ [South Wilts. p. 81. W.P.]

circumjacent parts had attained their present thickness, the thin crust here had been torn or forced up—from that period the under soil continued subject to disturbance from intrusion of burrowing animals which obtaining access to the earth through the {passage} {breach} beneath the rock into a secret branch beyond denominated the Wolf cave—a horizontal sewerlike hole was thus excavated by them, round the edges and along the course of which modern bones of Fox and Rabbit in every stage were intermingled promiscuously with fossil—the whole greatly discolored from exposure, of a blackish green color—as we went on uncovering the bed the bones of Glires, Cat, Bird, and Rodentia joined with those of Hyæna Horse and Deer were thickly disseminated and firmly infixed in the earth not unlike reeds {thro a mud wall} {in a clay hut}—

The matrix was a saponacious brown soil compounded evidently of {decomposed} {the residuum of} animal matter mixed up with red marl—Immediately beneath this layer the earth turned brighter, was firmer and charged with fragments of stone—the small bones became less frequent less numerous and for the first time large teeth and bones now began slowly to make their appearance and to pierce the stratum of clay—the character of the whole deposit changed sensibly from the {upper} {incumbent} covering—The space examined was only a few feet round—I attempted to enlarge it and after great difficulty ripped up a slab of the stalagmite at the edges of the breach—when behold the soil at this summit was precisely identical with the lower just examined a pure red marl—and the bones of both situations surrounded by it of the same description, fresh and undiscolored—The more {we succeeded in removing the crust} {of the surface was uncovered} the more this identity was strengthened—It was clear that the deposit was not limited to an isolated patch here and there as in the breach just opened but that it ranged under the walls and floors coextensively with the open chambers—The fossil contents were not merely a straggling tooth a bone of a Hy. or rabbit casually picked up here and there but an assemblage of animal * * * from an Elephant to a mole [56] swarmed thro the clay. masses of rock and blocks of spar were huddled confusedly thro the deposit with fossils wedged between or crushed beneath their weight—The crust over all was three feet deep and almost impenetrably hard and rendered further impracticable by the incumbrance of the huge fallen slabs of rock heaped upon each other to the ceiling—this new field demanded a commensurate scale of operation—all the

usual apparatus of the quarry and mine, sledges, pickaxes and shovels—and {discretion} {skill} in employing them without detriment to the remains—Hitherto I labored alone with a paviors pick—I now proceeded to excavate occasionally assisted by persons of great intelligence and experience—Half a doz workmen properly appointed labored hard in cutting away the crust which was firmly cemented together.

The central area of the sloping chamber is covered with a [58] solid pavement or brecciated crust composed of divers substances precipitated during its formation from the upper eminences and subsequently cemented together by the droppings principally. Large masses derived from the disintegration of the rocky vault, polished pebbles, charred wood and bones, vestiges of ancient fires—bones of Deer and Hog—broken pieces of spar—and towards the surface modern bones of animals the remains of the prey of foxes or of the repasts of visitors—marking the period of increasing resort of the cavern. By the accession of these adventitious matters and their consolidation by the drop a thick stratum was formed varying in depth from two to four feet—

At its extreme branchings into the arcade on one side and Wolfs cave on the other situations protected by their distance from the slope from the fall of foreign substances the flooring consists of a pure cellular tufa very rarely containing any imbedded matter—while the intermediate declivity—subject to the addition of the casual substances brought in by visitors and predacious animals and of rocky and stalactitic fragments from the roof and sides is swollen to an irregular bulk—From a view of its broken edges it resembles a mass of ancient masonry that might be supposed to have fallen across the central area—The crust towards the upper eminence increases to an enormous thickness. Powder could [make] no impression on it—and the labor of the workmen being as unavailing we were obliged to restrain ourselves to undermining it—The crust remains in consequence standing across the chamber like the broad arch of a bridge—The vault occasioned by the excavations is sufficiently large to admit an examination of the constituents of the brecciated roof—but in exploring, it is necessary to proceed with caution—with the slightest disturbance masses of rock are liable to separate and in more than one case the experiment threatened to be fatal—

At the foot of the slope, the crust in place of reposing [60] immediately on the loam as is the case at the sides and in all other unexposed situations rests on an uncompacted layer of stones somewhat like a foundation—So deep is the bed of

rocky fragments, that the cementing matters consolid^d only the uppermost stones—except when following a vacuum in the heap it escaped down to the surface of the diluvium and spread over its superficies with a firm plate—thus was produced the semblance of two strata of stalagma separated by a stratum of loose stones—At the commencement of the workings from [this] singular appearance was hastily assumed the existence of two distinct depositions of rubble and crusts (Mr. Northmore)[†] or alternating stalagmata and rubble—crusts deposited at successive intervals. I inclined to this supposition—and my attention was thus early arrested by this anomaly and as we advanced I {sought} {looked out} for confirmation of this view in the extended unexamined area around—but beyond a patch here and there of a few feet in circumference clearly explicable on the ground stated—the oblique course of the fluid was clearly traced from the top in its windings thro the stones to its settling on the mud, there was besides in this chamber no repetition of crust. Nor in these insulated patches of rubble intervening between the two crusts was there discoverable a vestige of mud or of bones or of any other characteristic that might distinguish it into a distinct deposit. The ingredients were simply the lowest portion of casual angular substances which go to form the brecciated crust that overspreads loam in the centre of this chamber.

Spots of charcoal occurred at different depths in this crust—In the crevices were found the shells of *Helices* and * * * * and the skeletons of rats, mice and Bats that retired thither to die—with hazel nuts and black spots apparently the vestiges of decayed vegetable matter—all these foreign * * * * were more or less encrusted, but within a few inches of the surface, the remains of the Dog, Sheep, Horse, Rabbit and other [62] animals that at present occupy the modern surface were very abundant—about midway I found a piece of wood about eight in. long and three broad—with a groove in the middle—it seemed to have been prepared with an axe—Mr. Northmore possesses a piece of wood shaped like a sandal, which was found by Mr. Braham, Watchmaker—The latter states that he extracted it from the lower deposit of mud—At the time of the discovery I was [in] an adjoining part of the cave—and on the report of a Druids sandal as it was fancifully called being found I repaired instantly to the spot—and examined the relic—There appeared none or at least very little of the red mud which envelopes the fossils to adhere to

[†] [See Trans. Devon Assoc. 1868, vol. ii. p. 486. W.P.]

it—I remarked to the finder—there was rather a brown mouldering * * * * like the color and condition of the piece of wood discovered in the crust—At the time it was picked up the persons were engaged in breaking away the crust from which it most probably fell {out} {forward} into the excavation beneath. Had it belonged to the deposit of loam, it would have there is little doubt suffered rapid decomposition from the great humidity of the bed, which while it was favorable to the preservation of bones, as will be seen hereafter, would be destructive to wood—what were taken to be the remains of branches imbedded among the bones {left only} {consisted of} a black streak in the red deposit—

Had the sandal been surrounded by calcareous matter it might have been thus defended against decay—but I saw no trace of such an Envelope—

Diluvium

[64]

The bed immediately underlying the crust is composed of a fine sandy loam designated by the workmen sea sand—and plum earth—(a local term for light soil)—As you descend, the bed becomes more and more gravelly, and thickly charged with angular and rounded stones of divers strata, large blocks of limestone—referrible to the rock of the cave—spires of stalactite—slabs and cones of stalagmite. All Promiscuously intermixed among which were {the remains} {an assemblage} of several species of animals—The larger like the rocky masses determined by their weight towards the bottom—They may be traced upwards however though but scantily distributed.

About twenty feet below the surface the character of the loam changes into a considerable rubble composed chiefly of comminuted limestone derived from the detritus of the surrounding rock in every stage of decomposition—This is the material which throughout its area almost invariably occupies the lowermost region of the cave and not improbably constituted the covering of the rocky bottom at the era of the superimposition of the argillaceous bed—The few bones that may still be detected at this great depth are like the rock carious and discolored—They scarce retain a vestige of their original form or properties They {fall to pieces} {lose their cohesion} at the touch like slacked lime—but for the presence of the enamel of the teeth the powdered substance might be mistaken for lime—such of the bones as can be extracted become hard on exposure—This is not the effect of their low situation—Some fresh and perfect bones have been dug up even here surrounded on every side by dark and

crumbling—Of this number is the fine head of the Hyæna Plate 1.† The disparity of condition is more remarkable than between recent bones and grave remains exhumed after a decade of centuries—

[66] The grand deposit appears in some measure sorted or stratified into the divisions just enumerated—The section at the grand excavation at the foot of the slope gives the following series.

1 A false floor or crust composed principally of rocky fragments agglutinated by calcareous cement—with {its} {an} inferior layer of incorporated stones—

2 Grand deposit of sandy loam abounding in the wreck of different strata—thro which animal remains abound—

3 A substratum of rubble supposed to overlies the fixed rock of the cave through its entire range—The rubble results from those portions of the shell which scaled off in course of time and suffered decomposition.

But these beds insensibly graduate into each other—and except the lowest result from simultaneous deposition—

The basis of the deposit is identical with the marl of the external surface of which it would seem to have {previously} {once} formed the moveable covering.

A bright ferruginous clay is the {principal} {predominant} constituent, mixed up with fine sand and quartzose gravel and a large proportion of calc sinter derived from copious infiltrations.

[68] From a careful observation of its characters it would seem that after the more weighty bodies had tended to the bottom, the turbid element {tranquilly} {slowly} settled down during which period all the {finer} {lighter} particles suspended in the menstruum were precipitated in the form of a rich sabulous loam. Tis this substance which constitutes all that extensive region of the bed {interposed} {that lies} between the crust and surface of lowest rubble—That it once occupied a considerably higher level than at present and slowly subsi^d is clear from the fact that the summits of rocks which now pierce above it into the open space are still invested with a paste of red clay somewhat like the coating of slime deposited on rocks in muddy waters left exposed by the receding of the tide. This was remarkably exemplified in a huge block of limestone that stood in the centre of the grand excavation—The surrounding mud had {sunk} {shrunk} away from all but its base, leaving an intervening vacuity—its sides and

† [In "Cavern Researches" the first Plate, or Plate 1 in numerical order, is termed "Plate B." Fig. 1 in it is that of a fine skull of a Hyæna. W.P.]

summit tho raised three feet above the existing level of the loam still retained notwithstanding marks of its former immersion in a surface of indurated clay which cased it all over—{corresponding} {not unlike the} indications were found on the {rocky sides concealed under a veil of crust} {adjacent walls after stripping off the lining of spar}. The depression naturally arose from the absorption of the fluid and soluble portions of the earth by the deep clefts in the rocky basin which we had frequent opportunities of remarking—and which at remote intervals occasioned further extensive subsidence in the innermost branches of the cave as will be shewn.

It may be proper in this place to make a remark which indeed applies generally to the entire field of loam, that in the central or plum bed as in their natural matrix the remains prevail in greatest quantity—It would seem to have in its progress to have entangled and surrounded the remains and fixed them in their present situation.

The Palates of Elk were extracted from this bed—

It may also be noted here that the character and conservative virtue of the loam varies much according to the measure of calcareous infusion. In its absence the loam is light, pulverulent and crumbling—not unlike clay mould in graves. The fossil contents are affected by the nature of this matrix—they are mouldering, discolored, suffer the loss of their compactness and sharpness of outline—and the deeper [70] you {go} {fathom} into the clay bed, the more strongly are those characters expressed—Even the rocky fragments suffer disintegration to a dark powder which at first was difficult to explain, until we lighted on masses in the stage of partial decomposition. The pieces of spar crumbled to ashes.

From the decomposition of these different matters a heavy fetid odor exhales, when after being long sealed from the access of air the bed is first opened.

But in those situations where the bed is thickly saturated with infiltration, the mass becomes indurated into a species of breccia—the several substances are in the soundest state of preservation—The bones retain apparently all their original freshness but possess a superior degree of solidity—Percolating thro the pores and fractures into the canals of the cylindrical bones it completely occupies them taking the form of the cavity as plaister of Paris does {in} {of} a mould. When broken the medullary cavities display their spongy structure curiously injected with calc sinter—this is particularly the case with those lying near the surface—but those lower down

with a pure white and more commonly with a red colored earthy paste—Many of the bones in consequence acquire the weight and compactness of mineralized bodies—they ring with a blow and break shortly into sharp splinters.

This character is particularly observable of the fossils collected at the foot of the slope in the large chamber—there they are impacted in an argillo-calcareous bed, from which it is difficult to detach them entire, excepting when with a sharp blow on the mass they start from the envelope like a shell from a flint—and then they leave a perfect cast of their form in the earth with their external laminæ generally cleaving to it—The fossils extracted from moist earth must lie exposed a long while to the air before they are found [to] adhere to the tongue—but the bones from this bed possess this test when newly extracted—They were dispossessed of their gluten by the absorbing action of the lime—tho externally they evince no indication of the loss—their color is even more [72] brilliant than in modern bones.

Rubly Bed

is composed of the detritus of the fixed rock in different stages towards decomposition—the outer laminæ reduced to a dark powder emit a fetid odor. The fossils dispersed through it teeth and bones have suffered corresponding changes—frequently an ash colored streak is the only remaining vestige and but for the discovery of the enamel of the teeth still struggling with decay it might be mistaken for the residuum of decomposed spar—Even those best preserved are ready to disintegrate at the touch—but if carefully removed in their envelope of clay they recover somewhat of their hardness in the air—but their natural color and distinctness of outline no longer remain.

Remarks of Workmen

Insulated patches of this material frequently occurred during the workings in the heart of the loamy bed—and it was not uncommon to hear one of the party on meeting with it exclaim—Now I have fallen in with the rubly bed—few or no perfect bones—everything in a mouldering state—and after digging a few paces forward the same person might be heard to remark “I have again entered upon the fine clay—here we have bones entire and in abundance.—

[74]

Second Search

The great excavation was for the present abandoned and

after a consid^e interval employed on the other branches re-examined—It was feared that in the ardor of the first search facts of importance might have been overlooked. The mass of mould thrown up on the former occasion was therefore a second time turned over and carefully searched but nothing new was brought to light—but our previous observations were confirmed. Our next object was to ascertain the nature of the unexplored layers beneath the loose stuff—and lay open as far as possible the bowells of the vault—with this view the surface was cleared away—and commencing at the point where the previous excavation terminated a shaft was sunk perpendicularly to the depth of 15 feet—which added to the previous perforation thro the upper layers made in all a depth of 23 ft from the surface—Considerable difficulty was experienced in penetrating thro the lower members of the deposit from the {opposition} {intervention} of large blocks of limestone lying across the way—after ripping them up piece by piece we arrivd against the soft loamy soil interposed with numerous remains between the masses—many of the largest and finest fossils were extracted from these situations—of this number is the humerus of an Elephant dug out by Lord Valencia—two portions of the jaws of Rhin—much bruised—The forepart of lip of a Horse, an exceedingly perfect specimen—Horns and jaws of several species of Deer—broken tusks and teeth of Elep—and an astonishing assemblage [of] teeth and bones belonging [to] more than twenty species of animals Carnivora and Herbivora. Excepting the mechanical injuries occasioned by the pressure of rocks upon a few specimens, which even in their broken state retained their freshness, the entire number was wonderfully preserved—

At this depth all the characters which were described in all the superior layers were repeated here on a much more extensive scale—The matrix was the same a fine bright red sandy loam—but at this depth it was more thickly charged with foreign substances, such as rolled pebbles of Quartz from the size of a pea to that of a tennis ball, such as constitutes the [76] comminuted shingle of the adjacent shore slightly rounded fragments of chert, grauwacke—red and green sandstone limestone *one side sometimes* coated over,† and granite more

† Many of those masses weighed several tons, were rolled against the foot of the base, and were so unmanageable that it was found most convenient to undermine them and thus get at the fossils—In the centre of the grand excavation there stood a rock of this kind it was from beneath it that Lord V. extracted the Humerus, while engaged in examining the earth some feet below it, the bank on which it partly reclined gave way, and bringing with it an avalanche of mould it bounded forward into the pit where I was en-

rarely—this last about {the form} {the size} of a cannon ball—besides broken spires of stalactite similar to those depending from the roof—and slabs and cones of stalagmite of every bulk the wreck of a former floor—these different miscellaneous ingredient bones and all were huddled together thro the mud with no more order than substances accumulated at the bottom of a torrent—or mouth of a river estuary.

Below this stratum the usual coarse rubble was spread over a ledge of rock which forbid further advance—There was no crust of stalag^{ite} observable on it—whether it was only a flake from the roof or the fixed floor its thickness and low position prevented us ascertaining

At the point of contact of the loam with the rubble reposing near the edge of the side lay buried under a pile of bones a head of a Hyæna—its palate was uppermost—an under jaw corresponding to the head in magnitude lay near it as if locked with the upper—

The processes were slightly rounded and zygomatic arch dashed in most probably in its descent from the upper branches—The bones which reposed a foot beneath it were in a crumbling state, while the head and accompanying remains were as fresh as if only recently interred. The convoluted membranes of the nostrils and the thin partitions of bone in the adjacent cavities were all perfect—and the surface of the head retained the impressions of the muscles and blood vessels quite fresh—the same of the bones.

[78]

Shell—

A broken scallop shell was taken out at this depth—covered over with the red clay.

Direction of Arcade

As we enlarged the excavation and advanced in the direction of the long and narrow corridor which branches off—the bones became less and less numerous, till they nearly disappeared—rendering it not worth our while to prosecute our researches further in that line—There was no variation in the character of the loam. The stalagmite was a pure deposit unmixed with other matters—from the disappearance of bones at this wing we are led to conclude that the central vault was the grand depot of bones—being nearly equidistant

gaged digging—I had fortunately {observed} {noticed} the breaking of the bank and had just sufficient time to throw myself back—I escaped being crushed—

from the two mouths—from its sloping inclination it was conveniently situated for receiving such substances as may have rolled down from the upper landing places.

Thin Lamellæ of Carbonaceous Matter—Streak of Charcoal—Boar

The only remarkable feature of the excavation in the direction of the arcade was a black horizontal streak which surveyed at the section is seen to cut into nearly equal halves the stratum of stalagmite. It lies about a foot below the surface, about an inch thick and five ft long—The calcareous deposit above and below it is pure and of a snowy milky white. The streak is formed of the remains of charcoal or burnt wood, portions of which I extracted in presence of Dr B [uckland]—who himself took out some half burnt cylindrical bones which he assumed to belong to Deer. I have extracted from it the jaw of a young Hog (Boar—) and some bones most probably belonging to the same animal—discolored either by the charcoal or smoke. There is little doubt that it is the remains of a fire.

Wolfs Cave

[30]

Having thoroughly eviscerated the central vault and examined its left branch opening into the arcade, I next proceeded to its right extreme in order to ascertain if the opposite side presented similar characters. Near this prolific spot which has already been adverted to as furnishing materials for the first plate and determining us to undertake the examination of the cave—There was no opening at this side into any other branch. The roof and floor nearly met, stalactite and stalagmite leaving scarcely any open space between. {From the experience of} {Having some suspicion of} its concealed treasures from its propinquity to the * * * * I was induced to set about undermining it by carrying a subterraneous gallery from the excavation thro the loam beneath the crust. It was found that the loam did not terminate with the {wall} {precincts} of the cave overhead, but ranged indefinitely beyond it—Having dug away the earth for some yards in the form of a tunnel, our next object was to force upwards the crust above—after some days struggle with a hard and thick plate it was effected, when a new and unexplained scene was disclosed to our view—a very low cavern with lateral branches—The floor was divided into natural troughs full of clear water—at the bottom [of] which recent and fossil bones were seen exposed undergoing incrus-

- tation—among which were particularly remarked the single plates of Elephants teeth partly inlaid in the floor. The exposure of fossils upon the stalag. was a strange anomaly and naturally arrested attention. As we crawled like tortoises thro the low range vertical holes were observed to penetrate the crust and loam deposit—round the edges of which modern and fossil bones were strewed—flakes of thin crust were found lifted up on their edges or turned with their upper surface downwards. The patches of the deposit thus uncovered offered a new curious spectacle—all the finer particles of earth escaped thro lower cavities and heaps of rock and bones were perceived hanging together by a slight cement in the vacuum.
- [79] The state of preservation of the uncovered remains is almost incredible—The calcareous dropping immediately entered and sealed up their pores and chambers and imparted to them considerable weight and solidity. The air was further excluded by a skreen of stalactite at the entrance. Their upper surface
- [80] was merely stained with a dark shade of mildew. The large horn fig. 1† an occiput of a Hy were found in this situation The long and narrow canal conducting into this new cave was likewise choked up with remains crowded together as in a catacomb. The number of remains here exceeded that in all the other chambers—and in the undisturbed situations they were found† [cr]ammed so thick together as to admit only a thin sprinkling of earth† [b] etween them, which
- [82] was of a darker and more saponaceous quality than ordinary and emitted an intolerable sickening smell as from a long closed grave, such as has been observed to issue from the accumulation of animal mould in the German caves

Mouth of Vault

About midway of the path on the right of the new cave an ovenshaped aperture yawned thro the rock like the mouth of a sepulchral vault. It was necessary to cut away the crust before attempting this fearful pass—and even then it required to screw the body thro, it extends ten feet {when} {after which} it ushers into a circular grotto sparkling with brilliant stalactites that nearly touched the ground—There are two apertures on the opposite sides—which are rendered impervious by the increase of the stalagmite—but by affixing a light to the end of a shovel I obtained a glimpse of a

† [Pl. H., "Cavern Researches," contains three figures of portions of horns, labelled "1 Horn of small Deer, 2 of Elk, 3 of Red Deer. Fig. 1 in this plate does not seem to be that referred to in the text. W.P.]

‡ [Part of the page torn off here. W.P.]

curious cell hung with icicle like pendants. An outlet thro the opposite wall showed the connection of this set of grottos with the upper branches of the two off shoots near the mouth thro which animals might have descended with facility into these secret magazines with their plunder—

The aperture on the other side resembles a port hole, looking into a deep pit strewed over with fawncolored earth and fractured crusts and fossils thrown up in mounds not unlike molehills, modern bones of sheep and rabbit also lay about—

The centre of the chamber between these appertures discovered a still more interesting display—Teeth, bones and Horns were spread on the floor curiously encrusted over like specimens from the dropping wells—The floor was perforated with pits—

It is in these holes that we find a clue to this strange anomaly in this nest of cavities [?]

Burrowing animals bored their way upwards into the body of the cave—Every time they emerged they threw up a quantity of the deposit with its contents in heaps on the surface—

Broken stalactites which they knocked off while ranging about and sheep and rabbits bones the remains of their recent prey were intermixed with the ancient matters.†

We now give as briefly as possible the result of long and unwearied excavation of this new cave, the lowness of whose roof and closeness of the air were great impediments to our progress—

At the mouth of the long and narrow strait stood a tall stalactite of a singular [f]orm; it claims notice from a singular resemblance to a Hindoo Idol [wh]ich‡ circumstance suggested the appellation of the “Idol cave” but in[ore]‡

† *Dropping of Light.*—As I stood surveying with wonder this extraordinary scene my light fell and was extinguished—Recollecting that I was alone and bewildered in a complicated knot of recesses, into which I was beguiled successively without remarking the course of their intricacies—out of reach and out of hearing of persons in the cave—but on the present occasion I was solitary—and still more so of those who may chance to be at the mouth. I shall not conceal that a feeling of horror came over me at the thought of the prospect of being benighted in this dreary vault, without a clue to escape. However the first shock of terror past I essayed to thread back my way into the body of the cave and thence to the entrance but not without encountering the projecting masses from the roof and sides. My greatest fear was lest I should stray out of the course into the lateral niches which it throws off at every step—On returning to the light I could not help thanking God at my delivery rejoicing at the results of my rash adva[n]ce‡ No other branch of the cavern equalled this newly discovered grotto whether in the number or interest of its productions.

‡ [Part of the page torn off here. W.P.]

- [84] particularly for standing on the head of a wolf—fig. P * * † one of its under jaws was dug out at the distance of a few yards in the inner grotto—The surface of the head was crusted over and its cavities charged with a breccia of minute skeletons of *Rongeurs*—some of which are left still adhering. Not many paces from it the head of a young *Eleph^t* lay oppressed by a rock—it retained its teeth and one of its tusks—The former not having yet protruded thro the alveolus were defended from injury by their strength of bone and are exceedingly perfect, but the Tusk was {fractured} {contused} and further crushed beneath the mass—a piece of about a foot long was extracted tolerably perfect—Being less compact the bones of the cranium suffered almost total destruction—

It is impossible without the suspicion of exaggerating to convey an idea of the enormous aggregation of remains including the new species of *Ursus cultridens* in this retired branch, they were heaped in incredible quantities against the opposite foot of the cave—some fastened like stakes into the fissures and interstices from which it was impossible to dislodge them without taking them to pieces—of this description is the head of the young elephant before mentioned—it was entangled and held fast by its tusk in a crevice of the rock—other specimens bore marks of contusion as if occasioned by repeated blows against the sides—while others were literally shivered to pieces—

Gravel and rocky fragments were likewise subjected to the same action.

On the other hand many fine and delicate specimens among which was *U. cultridens* were found quite uninjured in the midst of the shattered bones—

- [85] Two inferences inevitably follow and intrude themselves on the observer

1 first that this range including the adjoining large chamber was the receptacle of bones which from an inspection of their condition must have been {brought thither} {collected there} by beasts of prey—

2ly. that these bones subsequently to their introduction were with their envelope of mud violently impelled against the sides and forced into the narrowest and most tortuous recesses.

1 Many specimens are found wedged in narrow inaccessible crevices where no agency except that of a fluid could have impelled them—wedged like pebbles between crevices on the shore—

† [Pl. G, "Cavern Researches." W.P.]

2 a great portion of the bones and heavier masses are accumulated against the opposite wall at the bottom of the cave in great disorder—the surface sides and ends of the bones bear the marks of violent collision with harder substances—

3 that this collision took place within the bosom of the cave is evident—because the detached splinters exactly fitting into the larger bones lying near them—as in the case of the wolf's skull and its under jaw—corresponding tusks—and because the splinters have no appearance of having travelled from a distance—they are simply in the state of fragments produced from cylindrical bones split longitudinally

4 The action which thus fractured them was transient—There is no evidence of prolonged agitation—their fractures are sharp and angular—and numerous delicate and frangible specimens escaped without injury which in case of long rolling would have been ground to powder such are the tender jaws of the young of the several species scarcely more than mere membranous shells enclosing the rudiments of second series of teeth ready to supplant the milk ones which themselves are still standing—and which with continued agitation must necessarily have fallen out—and bones with their epiphysis yet unconsolidated and scarce adhering, which certainly would not have been the case supposing them to have been drifted inwards from the external plains thro the long and tortuous

[The following narrative occupies a few pages of "Fasciculus B," which had been left blank when the foregoing Memoir was written.—W.P.]

On the 14 Aug^t 1829. visited the cave accompanied by [13]† Master Aliffe. We commenced by searching the mould which lay uppermost on which we were standing—In the present case it reposed immediately without the interposition of a crust on the red deposit from which it was clearly distinguishable by the {blackness} {charcoal} of its substance which stained our hands and cloths as tho we had been working in a coal mine—On the top was naturally composed of recent substances such as the remains of fires, and feasts, and the other ordinary matters as might be expected—about a foot beneath a new scene disclosed itself, fragments of pottery, both coarse and ornamented, lay strewed about in abundance mixed up in a dark crumbling mould containing a quantity of marine and terrestrial shells, such as *Patellæ* (limpets), *Ostrea*, *turbo*, *pinnæ*—*Helix*—*solen* ?—

† [There is a duplicate page 13. W. P.]

The nacre had in most cases separated from the shell and frequently {deceived} {deluded} the eye with the semblance of pearls and were anxiously caught up—among the broken pottery there were intermixed a multitude of remains of divers species—of stag, ox, Fox, Rabbit and rodentia—many of the bones were black as the charcoal layer which held them and nearly decayed so that they were difficult to determine—others tolerably perfect as the bones of ox—a large rock now stood between us and the next stratum—among the bones I discovered some that are curiously fashioned by art—the articulation of the larger extremity was left untouched while the other was tapered off to a point and polished—we found three specimens of this sort—one the arm of a * * * the other the brow antler of a stag, the third * * * and a fourth was previously found in the interior of which notice is taken in its proper place—when we lifted over the rock a still more * * * discovery was displayed to the eye—pottery, charcoal, human teeth and bones, flint relics, copper ornaments and mounting of tin 2 lumps of virgin copper ore were pressed together into a cake on a large flat stone against which they were violently crushed by the superposition of the rock just removed—The circular slates used as lids of the urns in which state they were found in an {excavation} {barrow} in Powerscourt, County Wicklow.

- [15] We collected on this spot the remains of two sepulchral vessels—one {was} {belonged [to]} a plain urn slightly indented, of coarse sun-baked pottery, the edge about half an inch thick—It most probably contained the ashes which were spilt about and two black spearheads mixed up with it—

The other fragments were thinner, and most highly ornamented answering in every respect to those small figured vases found in barrows and designated by Sir R. Hoare as drinking cups. The pieces of both vessels were scattered at a short distance from each other on the flag—and were evidently connected with the human bones, flint relics and other substances just described as grouped together—the whole forming a distinct interment—From the position of the bones, it would appear that the body was laid nearly in the centre of the entrance lobby with its head towards the East or mouth—Its teeth most of which I collected are with one exception sound and undiscolored—that they belonged to a robust adult they and the fragments of the skull and vertebræ abundantly testify—The front or incisor teeth are what are called double teeth—Portions of the extremities, such as the phalanges of the hands and feet were also found and other parts of the frame,

but owing to this passage being public liable to excavation by persons impelled by curiosity or search for treasure not willing to proceed farther interiorly, the floor had been partially disturbed. The bones being restored to a more retired resting place in an adjoining niche the ground under the skeleton was next explored—Directly under the burial stone the earth changed its color to a dirty red somewhat resembling the Diluvial deposit in quality also. It was however more crumbling. Here again another phenom. rose upon us—arrow and spear heads, stone axes—all of white flint—deprived of their siliceous property like animal bones of gluten and as pliant [?]
—and beautifully shaped occurred mixed among fossil teeth and bones of Herbivorous and Carnivorous animals—numerous chippings and some blocks of the siliceous material were likewise discovered—but here no vestige of pottery or ornaments was to be seen—simply flint weapons scattered through the surface of the mud—Having cleared away the crumbling stuff we arrived at a more compact deposit—which was more stiff, red—and firmly solid.

Hitherto the soft earth fell away at the least touch of the [17] hammer, but now the pickaxe was called for in order to raise the large and angular stones that were set in a stiff clayey bed—Here the unadulterated Dilu[vium] spread before us—we looked in vain at this depth for flints or pottery or H. bones—only the usual contents of the Diluvial bed, mere animal remains came up with the spade.

An inconceivable quantity of a superior black pottery, highly glazed and richly embellished was found nearer the surface. Traces of the Lathe were visible in the circular grain—the beautiful fern like impression on its lips and sides were evidently made by an instrument like that used by bookbinders in indenting vellum—This species and pattern most abundant—Stone having one surface stained a bright red—flat inch square—A piece of metal retaining a yellowish tinge but greatly decayed—like virgin gold—Round Pebbles of chert, and red jasper, small oblong bids [? bits, or beads] of crystal opaque—Shells used as necklace—The flint little changed in color—and not adhesive—The piece of silver was inlaid in wood which mouldered away—there is also a segment of a ring or armlet, which also was set in wood as the grooves shew—

From the nature of the accompanying relics there can exist no doubt of the skeleton being an ancient Briton—The rude sunbaked urn with its attendants, burnt ashes and charcoal, pebbles for the sling, flint, arrow and spear heads for the bow

—The fragment of the breast plate preserved in the piece of * * * silver—of necklace in the serpent shaped * * * of copper—the lumps of virgin ore—heaps of shells and pins and bodkins of bone a * * * all attest an analogy to the interments in barrows decidedly British—but perhaps of Romanised Britons, for the relics of art show a more advanced state of civilization than the rude and solitary flints found at a greater depth along with which, neither in this place nor in any other similar locality in the cave have there ever been found any other indications of human resort—In their time metal would seem to have been yet unknown, or if known, not used—They were the mere savage nomads in the very infancy of a renewed (?) race, to whom life was yet little removed from the condition of the beasts they pursued—

[19] It may throw light on the form of the brass serpent shaped ornament—"Antiquity has ever respected the serpent as an emblem of immortality and from shedding its skin annually a symbol of renovation—It was introduced on the coins and altars of the ancients and even temples from their resemblance in form assumed the title of *Dracontia*," unde? Adder or snake stones were worn by different orders of the Bards each having its appropriate color—the notion of their rare virtue was universal in all places where the Bardic Religion was taught—

A relic of a similar shape but not half the size and made of tin was found in a Druid Barrow on Sutton Veney Downs, not far from Putwood Wilts—

In the same cave was found an oblong piece of blue slate which seems to have been worked up into beads and breast-plates—

Among the other ornaments enumerated were some segments of circles and square pieces of this mineral.

Near it was found a large plate shaped circular flag of blue slate about a foot in diameter, rounded at its edges—bears no character.

Fibulæ of marl or chalk—similar of a * * * in the interment—as also small spires and cones of stalactite which singular enough are sometimes too found in Tumuli. I found one curious fibula of a blackish substance—it is of a small mushroom form and remains of the stem are visible—

Aug^t 19. We {turned away} {made a digression} from our regular work to deepen the path round the fallen rock which obstructed the passage into the large chamber—Having cleared away great heaps of rubble at the base of the rock one of the party began to complain at our expending our time

and labor on the proper business of the guide whom the Public pay for showing it—another of the Party replied that we ought not to neglect the public convenience for private interest and that possibly before we had done the Public would repay is [? us] by some treasure that may lie concealed in its gangway—the words were scarcely uttered when an oblong blackish stone caught my attention—Not suspecting its value in its disguise of mud I struck it with my hammer to ascertain the quality of the stone—it resisted half a dozen sharp blows before it broke across—when I took up the broken piece I could not contain my joy at finding it was the half of a black celt, the edge of the extremity was exquisitely polished and retained as fine an edge as if it had only been recently ground—near it was an oblong sandstone which was probably used as a whetstone as it is commonly found in company with it—it is finely polished—3 in long—several others had been [21] previously observed but not collected, their use not being known—It is formed [of] a greenstone. The celt is five in. long. and six in circumference at its trenchant end—all but the polished end has suffered by its interment—

It has perhaps been anticipated that the instantaneous fulfilment of the prophecy that the Public would reimburse its servants did not fail to furnish abundant amusement—near the celt lay a beautiful pin or bodkin of bone, polished all thro—and made of a compact bone such as the spike of a fish—along with which was also associated a bow shaped bone of the same hard bone * * * long—and two smaller, pointed, of a softer bone—the whole was concealed under a heap of pottery which evidently in an entire [?] state was the receptacle of these several articles and being dashed in by persons in pursuit of treasure who were probably the Rom^a was mixed up with them—The remains themselves from this intermixture of their earthenware, of ashes and calcined bones, Heaps of shells (chiefly *Patellæ*) charcoal * * * another axe, but whose form has suffered, of porphyritic Sienite was among the things.

The pottery was coarse but curiously impressed with * * * white specks.

A circular pit or cist about 3 feet in circumference sunk in the stalagmite received this interment.

In this and all the localities of Pottery, pebbles are constant attendants of the above enumerated substances, from the size of a marble to that of a swans egg—they are generally of the description that may still be gathered on the adjacent beach—but certainly of the handsomest kind. Quartz

streaked with red veins—or limestone * * * or a jasper like pebble, most of them are notched at their larger end as if for the purpose of hitching a bow string—Hence we have designated them for distinction sake “sling stones”—There remain still to be added pieces of grey gritstone—of a triangular form—not unlike a smoothing iron, there remain drills or channels in the three sides, which naturally explain themselves as the * * * in which the arrow and lance and perhaps hatchets were whetted—I met with them very frequently, but not perceiving their destination omitted to preserve them—but I have fortunately reserved a specimen or two—This is the only form in which gritstone occurs—it occurs no nearer than Purbeck. Measure at its longest angle 3 inches—

(Note on the rapid decomposition of articles left in the cave—the handles of the tools become brittle—and less firm articles fall rapidly to decay—)

[END OF FASCICULUS B.]

[FASCICULUS C.]

INTERIOR OF HORIZONTAL CANALS.

I RECOVERED from the effects of my imprudence visible in [76]† my altered health. The most robust of the workmen were generally most sensibly affected with nausea and vomiting—

Several jaws and teeth projected from the internal sides and were exposed on the floor of these perforations—all very much decomposed as likewise the loam which assumes a pale and {crumbling} {arid} character. The traces of modern animals are visible in their dung, and fragments of sheeps bones {scattered over} {strewed about} the floor—

The constant trampling of burrowing animals aided by the percolation of water thro the finer particles of the earth have contributed to the subsidence of the earth, and absorption into lower cavities, of such capacious extent that they swallowed up without any visible diminution numerous cartloads of the loam stuff discharged into them from the excavations.

It is probable that rabbits and Badgers first commenced burrowing from the outside, their bones occur frequently in that direction and that they were subsequently disposed of by Foxes whose habit it is to invade the perforations made by other animals—

Remark

The general level of these horizontal excavations is about 20 feet below that of the two existing mouths, considered in connection with other circumstances, as namely the accumulation of bones in low situations, necks, where animals alone could have {brought} {carried} them—and the physical impossibility that the enormous mass of loam could have entered exclusively through the present mouths incline us to think those canals {open in the concealed mouths} {communicate with embouchures} of the former entrances—and

† [The author designated this Fasciculus "No 2." From its "Index," it commenced with Page 73. This, with the exception of the merest scrap, has been torn off and is missing. Of "No 1," a few fragments alone remain. Among them is the "Index," showing that No 1 extended from Page 1 to Page 72. W.P.]

this opinion is rendered probable by the cross currents which traverse them—

[77]

Two long Tongues

I have traced the connection of these horizontal canals with the two long tongues which penetrate into the base of the hill below the vaulted mouth and seem to open in ancient apertures of the cave—their entire area is honeycombed with foxholes and the loam thrown up in mounds round their edges is mixed with scales of the Beetle, modern and fossil bones, all of which as well as the rocky contents resembled bleached or calcined substances exposed on a common

In attempting to reach the extremity of the lower tongue at a point where it suddenly expands into a large grotto, the hollow floor gave away like a pitfall with my weight and sank {into} {down between} a cleft of the rock—I shall not dissemble my terror at my sudden descent, my efforts to escape would but cause the ground to sink still deeper and deeper into deeper abysses

“At subito se aperire solum, vastosque recessus
Pandere sub pedibus, nigraque voragine fauces”

The crash routed some animals from their subteranean abodes I heard them forcing their escape towards the outside thro the incumbent earth and perceived their footmarks—The hounds frequently assemble outside about this point and frequently earth foxes there—

Such are a few of the {adventures} {perils} encountered during our researches. They tend to show in some places disturbance of the loam from the intrusion of animals probably all along from the time of its deposition—but the deposit is identified by its characters analogous condition of organic remains and the occurrence of a græcum with that in the chambers previously explored—The fossil bones only in some cases have assumed a dark greenish aspect, but still retain their tenacity and firmness—while the modern bones of dog and sheep associated with them fell at the touch to [78] powder. The former having been saturated with the calcareous moisture during their long sojourn in the earth previous to their disturbance. Wood is thus protected by the moisture it imbibes from decay.

[79]

Long Arcade

We now resume our labours in the sloping chamber at the left wing or entrance to the arcade where we left off—The difference in the stalagmite at this point is remarkable ex-

hibiting a sudden transition from the stony conglomerate of the centre to a spongy tufa pure from extraneous matter of whatever kind, with the exception of a thin horizontal seam of charcoal within a few inches of the top towards the surface, the upper laminæ were discolored with modern mould and calcined bones the {remains} {records} of fires made by visitors.

The subjacent bed is likewise deserving of notice. The loam is of the {tenacious} {strong} and ferruginous character and identical with the argillaceous soil of the surrounding district—and tho the centre of the chamber is stored with the bones of numerous species, this side is almost entirely destitute of them an occasional specimen {only may be found} {marks that they are not entirely wanting}—

This scarcity of organic remains in the loam is referrible to the same cause as the absence of stones in the crust—Their secluded position protected both beds from the fall of substances from the elevated platform above—for the opposite reason the centre became the common receptacle of {these different} {any casual} materials, in addition to those dragged down there by animals.

The loam may be therefore viewed in this retired situation as occurring in its virgin state free from the admixture of animal matter which undoubtedly modifies its character in the adjacent excavations—

As you advance {into} {along} the arcade, the floor discovers marks of disturbance at every step—a coarse rubble is strewed over it covered with an irregular crust of patches of variable thickness—the rubble is mixed with the red loam and few or no bones are met with, but in the crevices of the rocky sides they may be traced, as well as *Album Græcum* surrounded with sandy clay. It was in this bed I discovered the Rhin. tooth alluded to among the discoveries of my first search in company with Dr Buckland—About half way on the left of this long passage our attention was drawn to 3 circular hollows in the floor—about 3 feet in diameter—lined down the sides with a thin waving {crust} {paste}—The greasiness of the earth and the presence of Bears single teeth in different states of preservation inclined us to {consider} {regard} them as the beds of the Bear whose habit it is to crouch in particular spots, but the occurrence of charcoal and other indications of the presence of man in the vicinity of these hollows induce us rather to regard them as rude hearths or ovens scooped out by savages, round which they collected to cook and enjoy the spoils of the chase—The discovery of

the half burnt bones of Deer in the upper plates of the crust, as just recorded, favors the conjecture. The thinness of the lining of stalagmite intimates their comparatively modern origin.

The nearer the approach to the cul de sac and the contiguous cluster of chambers, Bears bones and album Græcum are found in greatest quantity.

As you pass from the arcade into the cul de sac a scene of disorder {meets the eye} {obtrudes on the eye}—blocks of limestone—slabs of floor reversed and inserted in a new floor, like insular flakes of ice imbedded in a second crust—

- [83] Underneath this irregular pathway spread a dull, unctuous earth of a brownish hue, thickly impregnated with calcareous and ferruginous matter—from which proceeded an intolerable effluvia—but tho considerably affected by the mixture of animal and vegetable matter and exposure, the matrix is essentially the same as in the other chambers—

In a lateral alcove of this apartment the Rev L. Welland discovered the magnificent under jaw of the gigantic Bear—fig. * * *† and I have myself discovered here in the loose earth without any covering of stalagmite sundry teeth and bones belonging to the same species. The exposed remains are porous and stained of a bright brown colour—those in the ground as well as a.[lbum] G.[ræcum] acquired a reddish tinge and compactness like mineralized bodies. near the bones were observed heaps of the tubes of stalactites.

But the most remarkable circumstance of this cave consists in the extraordinary quantities of album Græcum {detected} {abounding} in this range of caverns both in the disturbed and undisturbed sediment—whitening it like lime over a newly dressed field. Not a flag or block but disclosed heaps of it, sometimes crushed by the masses—and in other places uninjured adhering together in balls and exhibiting the tapering point produced by the sphincter anus—there was no difference between these fœcal deposits and those of the Hyæna in the Exeter Change, except in the far greater size of the fossil balls—corresponding to the superiority of size—the ossious substance is the same in both—in some of the f.[œcal] balls undigested particles of bone and enamel detected. Single teeth of the Hy. and some small mumbled chips of bones lay near it.

- [85] There is a singular coincidence between the condition of this cave and that modern one in India of which Cap. Sykes has transmitted to this country so interesting a description—

† [Fig. 2, Pl. D, "Cavern Researches" W.P.]

he from the almost exclusive accumulation of the Hyænas fœces in particular spots infers that certain chambers of that cave were dedicated to Cleanliness—and that in those secluded retreats few or no bones occur†—

This description is in its details quite applicable to Kent's Hole—It appears to have been preserved to us in its actual state as when occupied by the extinct Hyæna—suddenly overwhelmed under the mud like Herculaneum and Pompeii under the flood of lava which sealed—While reading his letter I imagined myself reading the history of another sealed one the duplicate of Kent's Cave and not the account of a living Hyænas den—

From Cap. Sykes account† it is also evident that the Hyæna dragged skeletons of animals piecemeal into their den on which they feasted until hunger again drove them abroad to prowl in the desert or dig out from the sands the victims of overwhelmed caravans—like the Hy. mentioned by Bury which disinterred human bodies.

This retired set of chambers in Kent's Hole may be regarded as the principal resort or cloaca maxima of the cavern—

It has been already remarked that A.[lbum] G[ræcum] is also detected in the great excavation but generally in single balls that might have been caught up by the agitated mass in its progress—There were however found collections of it in the indurated earth accompanied by teeth and bones—There are three or four similar masses in my collection—and album Græcum has been found in a crumbled state lining the cava- [87] ties of bones or disseminated in the form of powdered tufa or lime thro the loam—

On the right hand of the cul de sac the floor ranges under the impending rock which at first sight appears to be the lateral boundary of the chamber. As you scramble along the eye is struck here with a singular phenomenon—plates of stalagmite shoot across from rock to rock like bridges, and exhibit the remains of gravel and bones still adhering to their under surface or roof—There is a vacant space of four feet between this false roof and floor—the latter is formed of the materials which separated from the former. This anomaly which might mislead the casual observer into the error that some visitors fall into in beholding somewhat similar phenomena in the German caves, and who actually believed that the roof was paved with bones will be explained in our account of still more extensive subsidences in the adjacent Bears den—

† [Edin. New. Phil. Journ., vol. xvi. pp. 378-9. W.P.]

Stooping under the overhanging skreen which forms the left flank of the cul de sac you ascend a few steps and on hands and knees penetrate thro a long close strait aptly called the oven—It opens into the Bears den—From its elevation above the level of the surrounding floor and its hollow sound along its whole way, it appears to have stood firm as an arch when the ground beneath sunk down.

[89]

Bears den

The floor of the Bears den was studded with pyramidal mounds of spar supporting corresponding pendants from the roof—Fallen masses were strewed about and some of them were incorporated with the crust—and some large blocks were observed to have been moved out of the way into natural alcoves at the sides—There was something peculiarly picturesque and bold in the spectacle—

An irregular crust overspread the floor—of a bright ferruginous color and of such hardness that it yield^d fire with the blow—this may be owing to the admixture of silicious particles with the infiltrations from the roof. This crust was about a foot thick—and was based on a shallow bed of indurated rubble, tubes of stalactites collected in heaps [in] particular places similar to those mentioned in the description of the cul de sac, a great abundance of a Græcum were observed in it, mingled with an unusual proportion of Bears teeth—On further examination it was found to exhibit a modern character by the presence of an iron blade much corroded. This unexpected discovery decided us to examine it thoroughly and to seek for the cause of this strange assemblage—In a low crypt in the wall of the Bears den I discovered a thin bed of sandy loam glanced over with a slight paste. The remains of Bear were associated with skulls of Hy., Deer, Horse, Fox—it presented similar characters to the central bed.

On clearing away a considerable space of which, points of concealed cones were observed to protrude upwards into the rubbly bed and as we advanced what we had hitherto imagined to be the rocky bottom discovered itself to be a second plate of stalagmite—

It is curious that the cones of this lower crust were seated precisely under those of the upper—denoting they were successively deposited from the same tubes above, only divided by the intervening seam of rubble but the lowermost set exceeded by double the thickness of the upper and the depth of the stalagmite plate around was in the same proportion—

The under plate extended over the entire area of the cave [91] and was also ascertained to be continuous with the stalagmite in the circuitous avenues to this den and of coeval formation.

But while the superincumbent bed of rubble and its thin sheet gradually disappeared towards the elevated sides and proved to be limited to the central basin of this chamber similar anomaly was traced thro the avenues to this den—and in a crypt in the side wall of this den there was discovered portions of the skull and carcass of a Hy. much mutilated and gnawd—it was enveloped in a thin stratum of loam and strewed over a solid crust of stalagmite at the same time with the central bed, but owing to its retired situation not disturbed or mixed with foreign matter—A[bum] G[ræcum]—

By the removal of this partial bed the entire surface of the lower crust was displayed—it exhibited a most singular appearance—the whole area was {cracked} {riven} into large slabs, resembling flags in a pavement.

I was disposed at first view to refer this disruption to the falling of the masses which were scattered about, but the upper floor was not in the least fractured—but exhibited an unbroken plane these cracks moreover extended beyond the possible action of these shocks—

Farther inquiry enabled us to trace the real cause of their rupture, of the dismemberment to the subsidence of the great body of the loam and stalagmite which sunk bodily down in an oblique position—the upper members still abutting against the side walls to which they adhered by the attachment of the crust but longitudinally fractured—the depressed part left traces of its former adhesion to the opposite rock somewhat like the marks of a flooring in the interior of a ruin—

Undervaultings.

[92]

In a narrow neck which on the right hand as you enter issues from the Bears den, you come to a naked floor of rock perforated with numerous shafts or Spiracles by which you descending with the aid of hands and feet as down a chimney into a low space. They expand into a low range of undervaultings extending under the upper cave to a considerable extent, but too low to be accessible to any extent from the first landing place there is a gradual descent, step by step into a second and even a third terrace, like so many stories broken flags of stalagmite the debris of the successive formations were strewed about and partially inserted in the latest crust now actually accumulating—

In one place the crust went bodily down entire with the loam it covered—in another it may be seen extending across in the form of a bridge in more places it was shattered to pieces and reversed (surface)

These undervaultings inosculate with sets of others of a similar nature—They traverse the entire subterranean area of this division of the cave—coextensively with the uppermost floor—The set on the right of the circuitous rout have vertical orifices or spiracles in the solid body of the rock and exhibit precisely similar characters

These undervaultings or void spaces are evidently produced by degradation of the floor and separation of the diluvium from its vestment of stalagmite consequent to its engulfment in lower abysses below.

The fact of the existence of cave within cave conveys an idea of the indefinite magnitude of the cavern and of the vastness [of the] materials it engulfs—

[93]

Subsidence in Bears den. Cul de sac—

The same cause operated simultaneously in the approaches to the Bears den and likewise in the contiguous range of the cul de sac, reducing the level of the floor three and four feet, and in the undervaultings even to 10 and 15—by this fault the interior of the lower division, embracing one third of the entire superficies of the cavern was dislocated To what cause is this depression and dismemberment owing it will be enquired—It is a well ascertained fact that caverns have been enlarged by the sinking of the strata into subjacent gulfs and that the lower materials were followed by the superjacent beds as in the present instance—certain members of it may be intercepted in their descent and landed on ledge after ledge as the rock may project, thus forming successive {terraces} {floors} or undervaultings such as shall be shortly noticed—

The depression may be produced by the pressure of large deposits upon a precious [? precarious] floor of loose mould spread over the chasm of the rock, this may have caused the fracture of the first floor of stalag—diluted earth particles removed or by the subduction progressively of the finer portions by the sapping action of water assisted by the operations of burrowing animals, creating and enlarging a void in the lower region of the mass, and ultimately withdrawing support from the suspended materials above—This state of things would be soon succeed^d by the subsidence of the upper floor into the vacuity thus created and by the accumulating weight of the droppings would cause this and the dismemberment of

the solid plate either by its own accumulating weight, breaking into slabs like sheets of ice as we see takes place with plains of ice after the retreat of the fluid, or by the opposition of rocks in its fall—In this manner the floor appears to have given way marks of successive plates of crust and the different levels of the undervaulting serve like watermarks to indicate the successive descents.

Not merely the solid plate of stalagmite suffered by the [96] change of level, but the various materials it overspread were likewise crushed—

Remains under broken Flags

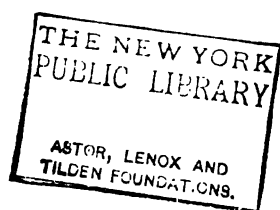
[97]

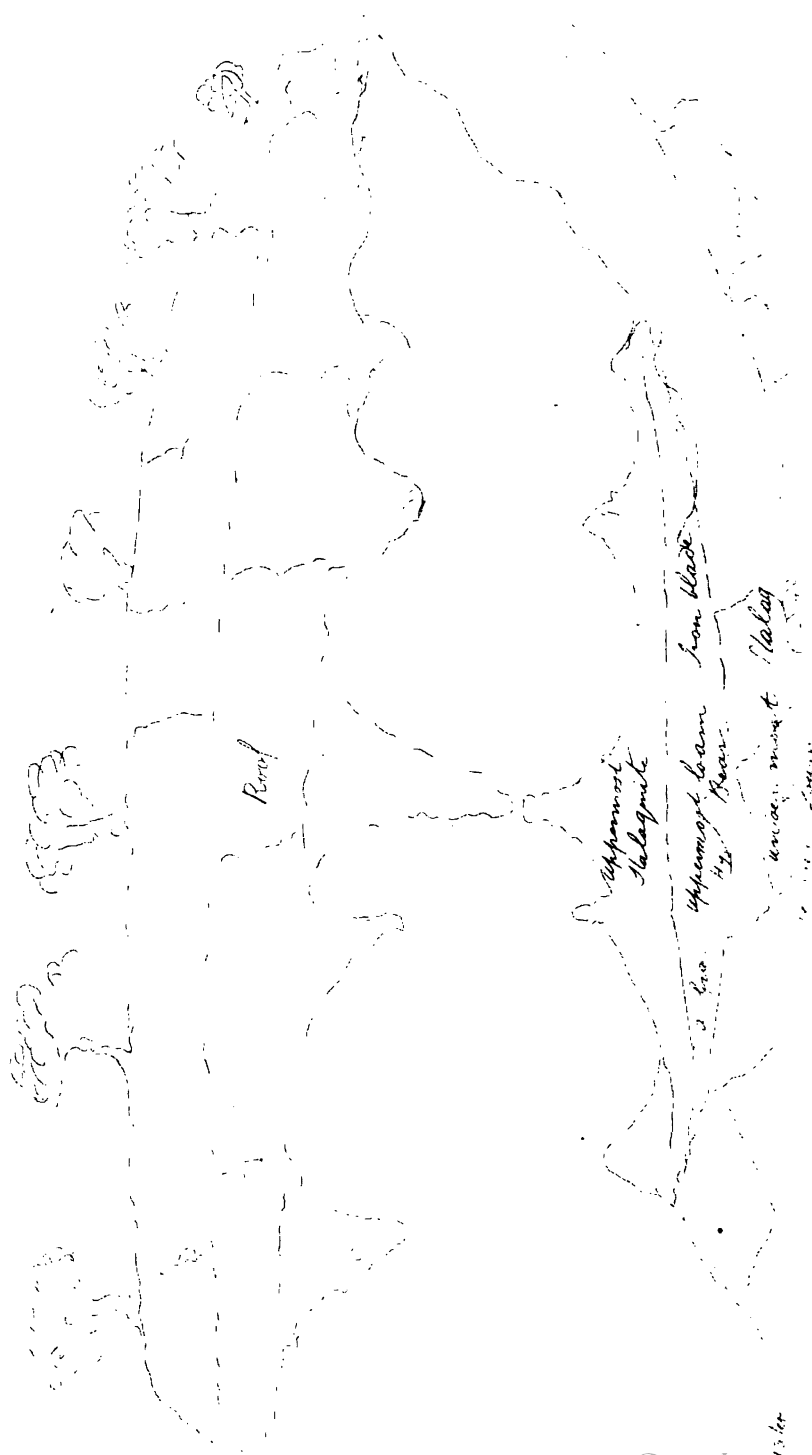
The average depth of the cracked floor of stalagmite was about two feet—It possessed the hardness of rock and but for its division into insulated flags it would have been almost impossible to pierce thro it—It is not sufficiently tenacious, for Powder makes no impression on this substance—Powder makes no impression on it.

The first flag we turned over displayed a curious spectacle. The skulls and bones of Bear crowded together {coated} {adhered to} its under surface. Flag after flag disclosed the same Phenomenon—but in one place numerous skeletons lay heaped on each other together—the entire vertebral column and its various other bones even to the phalanges and claws were discovered lying in their natural relation in a state of preservation as if belonging to the same individual—An occiput was by mere accident found enclosed in the centre of the upper flag—as in a mould of plaster of Paris. the corresponding part was buried in the loam at some distance and was crushed to pieces at the period of the fracturing of the floor—The chambers of the skull were lined with crystalline matter mixed with Diluvium and small stones—indicating that at the period of the irruption chambers were open to receive it. it is curious to observe how the processes of the head which projected upwards into the vacuum awaiting the advance of encrustation, that ultimately enclosed them towards the summit appear more and more discolored and porous—till the summits became quite black and crumbling—while the inferior parts which had been almost instantly enveloped, retained all their original freshness and integrity—which indicates that during the tedious process of encrustation the cave had been unoccupied.

Those remains which were impacted in the crust or lying immediately in contact with it possess all the characters of the skeletons of animals but recently destroyed. The bril-

- hiancy of the teeth and the living colour of the bones cannot be surpassed by any modern preparation and but for their extraordinary magnitude might pass for the latter—The bed on which they reposed is a rich saponaceous loam, exhaling a heavy effluvia—in some places indurated with hydrate of iron matter into a breccia—These remains are generally impregnated with ferruginous matter which has imparted to them the weight of mineralized bodies and they are not mineralogically altered—The organic contents of this loam are of different ages and stages of preservation, marking
- [97] different intervals of deposition. Some specimens of extraordinary freshness and lustre were intermingled with others of a greenish and black and brownish shades, which was occasioned by the hydrate of Iron with which they were penetrated and acquired in consequence a mineralised appearance—manifestly effects of long exposure previous to their sepulture in the loam—indicating different periods of introduction—
- [98] If it is objected that the remains which appeared uncovered on the surface were of subsequent introduction, it may be answered, that those remains connect themselves with those that lie undisturbed under the crust—first they are identical in species, condition, and character—
- 2 They retain the sparingly a slight covering of the same earthy envelope—
- 3 They are surrounded by fragments of stalagmite, which are evidently the remnants of the floor which formerly overspread them.
- 4 These fragments of stalagmite are sharp masses similar to the pieces with which the plate was broken in ripping up the floor in our own researches—they manifestly went to form a similar crust, and are mixed up with similar heaps of rubbish from the bottom, mixed with more modern charcoal, pottery, &c
- [99] The remains, both those that were impacted in the crust and in the loam suffered indifferently simultaneously fractures and contusions—the bones being broken across, angular stones were {driven thro} {impelled into} the surfaces of several like wedges—and in a few instances those specimens which happened to lie between overlying masses interposed between rocks were compressed and shattered to atoms—the cracks extended down thro the diluvium dividing the bones. In some cases one extremity of the bone was found fixed in the loam and the other protruding into the crust above—by the derangement of the floor these parts were dissevered—neither





the fragments enclosed in the solid envelope could be extricated generally without great injury—nor their corresponding parts broken into several pieces in the loam, though retaining their relation to each other—be satisfactorily reunited—a reunion of a portion of the skeleton however was {effected} {reconstructed} and a hope entertained that the entire skeleton of a gigantic Bear may be reconstructed but the attempt was impracticable—though numerous fragments of skulls and even perfect under jaws were collected and nearly the entire vertebral column—which seemed to have held together by ligature and sinews—and long bones—yet the parts were so crushed and mutilated as hitherto to defeat all our diligence and skill—

Section of Altern^s. Crusts

[101]

But the distinguishing characteristic of the undisturbed Dilu[viu]m consists not only in the prevalence of Bears remains, but also in their ungnawed condition—no evidence could be discovered in a single instance of the marks of the teeth or of other indications of the presence of the Hyæna, or of any other ossivorous animal—with the exception of the injuries produced by exposure and dispersion of parts by the irruption of the mud and finally by the downward movement of the deposit the remains appear to suffer no species of violence—but are in the condition of the remains of animals which for a long period existed and died tranquilly in this cave—and whose skeletons lay scattered over the floor unmolested by the intrusion of any carnivorous animal at the time of their immersion in the mud—The remains of water Rats and mice alone accompany them and from the marks of nibbling visible on some of the bones they appear to have been contemporaries with them and joint occupants of this den—

The annexed section will indicate the relative {arrangement} {position} of the alternating strata of stalagmite and loam—

Zig Zag Entrance

[102]

Along the zigzag entrance to the Bears den the same anomaly may be traced. A thin sheet of loam glazed over with a light film of stalagmite covers the ground—like the upper bed just mentioned it contains Hy. teeth and feces of Hyæna mingled with the remains of Bear and It rests on a second floor of stalagmite of equal depth and similarly fractured with that in the Bears den—but the contents of the

underlying loam vary from it—The remains of Bear occur here intermixed with the jaws and dung of the Hyæna, though not a vestige of the latter could be detected in the analogous loam in the Bears den of which this bed is no more than a continuation notwithstanding this difference in its contents—

The instant you pass the precincts of the Bears den, tho the remains of the Bear predominate in the circumjacent chambers, it is not found to prevail exclusively as in that den—In the loam strewed over the rocky floor in the narrow neck leading from the Bears den to the undervaultings the presence of the Hyæna is attested by the occurrence of album Græ. not any rock or flag of stalag. but discloses heaps of it exposed on the surface or imbedded in the earth—hampers full were collected here—and the usual attendants were soon traced in the tibia of an ox and femur of a Rhin broken in the Hyænas accustomed manner—corresponding in the freshness of their condition to the state of A. Græcum The fœces are generally compressed oval tapering off at the end last discharged—from the closing of the sphincter anus—

[105]

Undervaultings

A few feet beyond this spot you descend into the undervaultings—On first surveying this phenomenon of cave within cave my attention was attracted to the skull of a Bear engrafted in the clay and gravel coating the roof of the vault, and as I surveyed the ground I perceived that I was standing on the exposed remains of Hyæna and Bear some of which were slightly encrusted From what has been advanced in explaining the cause of the undervaultings it will be gathered that the roof in the present instance is no more than the under surface of the stalagmite from which the loam separated—The earth was thrown up in hillocks by burrowing animals—I soon perceived that this deposit in these undervaultings offered no exception in the character of the loam or its contents to those in the great excavations—Deer, Horse, Rhin were disinterred and no doubt Elephants too lie entombed here, but from the lowness and moisture of the situation it is impossible to carry on any extensive workings here—

The red loam of the other chambers was instantly identified as their envelope or matrix and we might have imagined that we were pursuing the diggings in the sloping chamber, but the remains do not appear to be in equal abundance—and there is a much greater proportion of the remains of Bear here—

Near the edge of the water a shaft about 6 feet below the surface was sunk—the soil became coarse and rubly towards the bottom as was observed to be the case in the other excavations—the floor rocky and was uncovered by stalagmite

Recapitulation

[107]

From the statements of the appearances of the Bears den and its vicinity it may be collected—

1 That the lowermost region of Dil[uvium] is identical and continuous with that in the remainder of the cavern.

2 the predominance of the remains of the Bear to the exclusion of every other animal except water rat and mice, in this bed, within the limits of the Bears den—

That no trace of the visits of the Hyæna or of any other beast of prey was discoverable in the condition of the remains of the Bear—but simply such injuries as would result from exposure in the first case—subsequently from sudden dispersion by the advance of a body of mud—and finally from collision with harder bodies occasioned by the subsidence of the entire floor into lower abysses—

That they are otherwise entire and unmangled like the bones of animals which tranquilly died and received sepulture here—

That in the heart of the loam the remains of the B[ear] exhibited the various grades of age and preservation of relicks of successive races of animals that at various intervals occupied this retreat and perished here—some crumbling and discolored mingled with others of extraordinary brilliancy—

We have also seen that the bones of several individuals were heaped together in particular situations—and that the bones of an entire animal even to the foot bones and ungual phalanges were distinguished in the heap—

That these congregated skeletons lay partly exposed on the surface of the loam and were in that state slowly invested by the march of the stalagmite, during which process they remained unmolested, retained their original position, exhibit in the greater decay of their projecting processes and summits the effects of protracted exposure—and that pending their encasement in a solid stratum two feet thick, they escaped [109] unmolested.

That the stalagmite which included them was during its formation, undisturbed unmixed with extraneous matter, except the bones that protruded upwards from the loam.

That the mansion remained unoccupied from the period of the habitation and extinction of the Bear during the long

interval while the solid floor was forming in this chamber and the circumjacent range of coeval formations

That when the floor had attained its present form it subsided along with its {under} {Sub} stratum of loam—and in its descent was rent into flags thro its entire area—

That from this epoch there is no appearance of subsequent deposition of stalagmite over this fractured crust and the fissures were unoccupied by calcareous drippings—but while the chamber was in the possession of man, during the period of its disturbance

But it saturated and indurated the overlying rubble that this rubble was strewn over its surface, and that it was by the agency of man is clear from the evidence of the Iron blade and other circumstances—

That shortly after this event, this cave became again unoccupied as appears from the commencement of a distinct plate of this stalagmite over the bed of rubble and its progress with some slight interruptions down to the time when we first ripped it up—

Inscriptions crowded on inscriptions on the walls, however, record the visits of the curious—one carved on the stalagmite in the year of the Prince of oranges landing in Torbay by “John Hodgson† of Ireland” seems to intimate that it afforded an asylum to individuals concerned in the public commotions of that period. Chancellor Bacon is also numbered among its visitors.

[111]

Inferences

The prevalence of the remains of Bear in the lowermost bed of loam is a decisive argument that that animal was the principal if not sole possessor of this abode—Teeth and bones of his species in all the various conditions which denote long residence abounded in this bed some manifestly belonging to remote generations were greatly decayed and blackish—they seemed to have lain loose on the floor subject to the trampling and pressure of animals and to the injuries consequent on this state—and the teeth and Jaws of the Bear in all the stages of growth from the infant state to the old and worn out, sound teeth mingled with those shed by absorption—such evidence as indicates that this gregarious animal occupied with its young this recess and that Individuals of different ages died and left their remains here—

In this assemblage of its remains there is evidence on the bones of the effect of disease and of accidents which they met

† [Correctly, “Robert Hedges.” W.P.]

with while yet living and which might have caused their death—The arm and Phalanges and vertebrae, the parts most exposed to injuries exhibit curious examples of disease superind[uce]d. Teeth broken while in the head by violence and those fixed in jaws that were still undergoing the process of absorption, were intermingled with single teeth that were scattered in quantities thro the loam—

Then the large and apparently connected skeletons lying near the surface belonging to the same species, but denoting by their perfect preservation a still later epoch—it is almost certain that they were the last {tenants} {inmates} of the den, some victims of some sudden disaster, “held their ancient solitary reign,” and that their skeletons thus strewed over the floor freed from their flesh when the entrance of the mud into this chamber partly filled the cavities of the heads and bones with fluid loam—not therefore destroyed by it—

“The bear,” say Buffon, “is not only a savage but a solitary animal. He flies from all society, avoiding every place to which man can have access, and is only easy where nature appears in her rudest and most ancient form. An old cavern among inaccessible rocks, or a grotto formed by time in the trunk of a decayed tree, in the midst of a thick forest, serve him for an habitation. “Thither he retires alone.”†

In the avenues to this den the same circumstances are [113] seen, the Bear is found to predominate and his remains present the same appearances—but the vicinity of the Hyæna is attested by the existence of his teeth and gnawed bones, tho but sparingly, and the extraordinary abundance of *A. Græum*—

It would therefore seem probable that in the Hy. visits to this remote division of the cavern for the purpose assigned in Cap Sykes communication,‡ that he had prowled about in the Environs of the Bears den and cautiously bore away if not lacerated on the spot the straggling skeletons of its rival but that he was however deterred by the superior prowess of the Bear from intruding into his domicile and of risking an open encounter with a superior enemy—

To some such cause must be referred the occurrence of the Bears remains exclusively in the central den near the water and of the untouched aggregation of his remains there—and of their dispersion among the teeth and other evidences of the Hy. presence in the adjacent centres. There may have

† [“A Natural History,” &c. By Charles Louis Le Clerc, Count of Buffon. Translated from the French by William Smellie (1817), vol. i., p. 346. W.P.]

‡ [Edin. New, Phil. Journ. vol. xvi., pp. 378-9. W.P.]

been conventional limits to the range of these adverse parties—neither actually invading the others den, but in the environs they may have met—but sullenly suffering the participation of the empire of the cave with each other (What are the habits of the Bear?)

- [115] It is certain that the advance of the plate of stalagmite above these entombed skeletons of the Bear was arrested by the intrusion of man into this mansion—The covering of rubble which overspread the solid plate in this cave and in the contiguous vaultings appears to have been thrown about during his sojourn in the cave—and it appears to have [been] derived from the neighbouring undervaultings and partly from excavations made in search of treasure

The presence of the blade of iron and the collections of the stalactitic tubes are evidence of his presence here

This last event may be traced with some degree of probability to the period of the introduction of the iron Spear and Etruscan pottery—into a grotto of the upper division and of similar antiquities into the contiguous caves of Anstis Cove and Berryhead—

- [117] *Irruption of mud—*

From the absence of organic remains in certain situations, and their abundance in others and particularly from the prevalence of particular species in the insulated Bears den we are warranted in concluding that they were not conveyed into the cave thro the medium of the mud, but involved by it in its progress through the cave—and that they were drifted forward and lodged in the nearest hollows and inequalities of the floor and that the advancing inundation after first filling the cavities in its way, passed like a flood of lava from cave to cave, dislodging cones and rocks successively enveloping the contents of each chamber till no additional mud could be admitted into the {chambers} {recesses}—This conglomerate in a state of fluidity supervened the actual rocky floor.

It appears also that this fluid body gradually settled into a firm consistence or bed—but that subsequently in particular localities, as the Lower division, the work of subsidence, continued after a long interval to go on progressively withdrawing the materials into subterranean gulfs—and ultimately undermining the entire Lower division—The consequence of which was the sudden depression of the floor and the dislocation of the superficies of stalagmite—

- [119] *Diluvium*

The materials conveyed into the bosom of the cave by the

movement above specified, were various—Of the constituents the shifting soil of the surrounding surface forms its basis—it is identical with that which at present covers the superficies of the country—a rich argillaceous loam {deeply} {copiously} impregnated and colored by the admixture of the red oxide of iron—

They are such substances as a great body moving over the modern surface would collect, modify and {convey} {discharge} into any open fissures and caverns occurring in its progress—and finding access to this cave thro the numerous windows in its sides rushed in at different points into the common reservoir travelling thro the most complicated windings and diffusing a nearly equal sediment thro the various ramifications of the cave—

Moveable—{Ingredients} {Constitutients} of Diluvium— [121]
Sea Sand—

The loam is thickly saturated with sand and gravel precipitated from a mud in a state of fluidity—which the laborers and masons occupied in digging constantly designated sea-sand—and with it were associated granular particles and polished pebbles of quartz, limestone, green and red sandstone, grauwackè and granite—accompanying these there were found innumerable large fragments of the same strata—some examples preserving their sharp edges and surfaces of a mass recently torn from an undisintegrated rock, mixed with others but slightly eroded and others rounded globular blocks—quartzose pebbles and boulders of granite were particularly noticed—Teignmouth porphyry. It is remarkable that those stony fragments whose native beds occur at a distance are invariably rolled while the fresh wreck of the adjacent rocks are scarcely affected, and among the heterogeneous assemblage were thickly scattered broken spires and cones of stalactite of every size—large tabular masses of limestone—

The spires had been formerly knocked off by the thoroughfare of animals, as has been noticed to be the case in the Idol cave visited by modern foxes, or by the violent collision of the mud with the walls—and others broken off and the cones {overturned} {disledged} by the violent irruption of the loam—by the same impulse the large tabular masses were separated from the roof—they generally lie horizontally in the centre of the loam like tombstones in the very position they fell—in a few instances they stand on their edges having sunk down in the loam—

The small angular fragments consist most commonly of [122]

limestone—and may be traced to the detritus of the shell of the cave from which similar fragments are constantly scaling off, and the slightly eroded to the shattered strata of the adjacent formations which I identified of the same rock of grauwackè and sandstone—

But the {parent} {native} strata of those which are reduced to pebbles lie at a greater distance—many of the pebbles and boulders have been recognized as appertaining to the granite range of Dartmoor—and it seems probable that they attained their rounded forms by agitation in those beds of the numerous {water courses} {torrents} which traverse the moors and {are} {constitute} the sources of numerous rivers in whose beds similar pebbles may be now found undergoing the same process.

The great movement setting in from the north as the granitic pebbles indicate collected in its course loose shingle from the beds of water courses, rivers, torrents and the sea shore—and as it advanced in the direction of the caves, it embraced the wreck of the local strata over which it passed, modifying it more or less according to the distance of the transport—and lodging portions of it in the open fissures and caverns it traversed in its progress—Similarly rolled pebbles of granite were found among the remains of Eleph. and Deer in the Dil. gravel which forms the low lines of cliffs on the west of Brighton—

The rolled masses are only such as might be drifted in thro small apertures—they do not exceed a good cannon ball in size. The large tabular masses we have already seen are not in the least rolled—and consist of the limestone of the roof and sides—

[127]†

Condition of the Remains

With the single exception of the anomaly of the Bears den near the water, the vast assemblage of organic remains distributed thro the several branches of the cave display precisely similar characters, and as regards respectively the matrix, the position, and the degree of preservation the Bears den coincides with the rest of the cavern—but in the predominance of the Bears species and the ungnawed condition of its remains it constitutes an exception—

In all parts of the cavern indifferently, they are most abundant in the sandy loam occupying a central place between the superficial mantle of stalagmite and deeper [?] stratum of rubble on the rocky bottom—They may however

† ["Page 125" is blank. W.P.]

be traced to the lowest region of the rubble, and on the other hand appear protruding thro the stalag. into the vacant space above, "like pigeons legs thro a pie crust"—This however was rarely visible owing to the density of the plate above their summits—The heaviest generally {sunk} {were found} towards the bottom of the fluid mass—

On the occasion of their immersion in the mud parts were detached from the corresponding parts and dispersed to various distances—many specimens were {contused} {bruised} by collision with rocky masses, or contact? with the {sides} {rocky ribs}—whereby the processes of the heads were sharply broken off, the zygomatic arches dashed in and the large bones split into longitudinal splinters. These injuries are easily distinguishable from the effects of animal violence but there is no evidence of rolling—no erosion of the angles—as is invariably the case with substances exposed to prolonged agitation in a perturbed fluid—

Independently of their great antiquity and the important [131]† speculations arising out of them, as a mere collection of the relics of numerous species of Quadrupeds, they may be regarded as most curious and ample. There is no character whether illustrative of age, of wear, of accident or disease that the anatomist would {look for} {require} in modern preparations—even the polish of the flat surfaces, {the coloring imparted} {different shining left} to their teeth by the nature of their food—and even the remains of the food itself in the cells of the graminivorous teeth—the oblique polish on the apex by the collision of the opposite tusks but may be perceived and studied in this collection. every particular and nicest distinction which a modern collection (supposing such a various and extensive one could be made of such variety of wild animals) could concentrate are strongly marked in this fossil collection—

As in relics of the overwhelmed mansions of the people of Herculaneum and Pompeii we {discover} {behold} all the peculiarities of their existing mode of life—or in the embalmed {animals} {subjects} of Egypt we contemplate the actual forms of that {remote} {singular} people—or still more properly, in the ice encrusted Rhin of Siberia—

The Physiologist in the various forms, connections, and relations of the parts of those animals, obtains new facts for his descriptions and his reasonings—

Very frequently the Epiphyses of those which had not yet

† [Pages 129 and 130 are missing. W.P.]

attained their full growth are still attached to them altho the slightest effort would suffice to detach them.

The greater number are so well preserved that they look as if the flesh had been only recently detached from them.

- [132] The cartilaginous canals of the blood vessels still preserved on the surfaces of Hyænas head.

The teeth of the graminivorous animals exhibit the stains on their surfaces and sides acquired during the mastication of their food—and a dark adventitious matter, apparently the relics of vegetable matter still occupied the interstices of the teeth and the chambers of those of the Rhinoceros especially

The fangs which were seated in the gums are distinguished from the uncovered parts by different shades of deep yellow as in the case of the living subject.

In the remains of young animals the enamel is generally brilliant of cream—in the adult of ochre colour—and in the old it is dark and striated—

Those specimens which are encased in the undurated loam or surrounded by stalagmite are in no wise distinguishable from modern bones, except that they are heavier in consequence of their internal lining of calc sinter or loam—They are of a cream colour inclining to yellow—but the remains contained in the humid loam acquire a greenish tint—are even heavier when first extracted than the former from the quantity of moisture they imbibed—with exposure they become light and porous—and the bones occurring low down near the rubble crumble to powder on {disturbances} {when disturbed}—but when extracted entire, they harden in the air—The horns were found in a pulpy state, exceedingly fragile, but with exposure acquired solidity—

- [133]

Animal Gelatine

The remains have undergone no conversion {into other} {of their} substances like the rock fossils—they are neither petrified nor mineralized, but simply incrustated or penetrated with calcareous or ferruginous substance

They are more compact and massive than grave bones which are generally porous and spongy—and preserve their natural color and integrity. They retain a considerable proportion of animal gelatine—

I have endeavoured to ascertain by subjecting them to fire the difference from modern bones. tho exposed to the {action} {test} of red coals they were but slightly affected emitting a very faint smell of calcined bones—Those from the Bears den which {appeared} {were supposed} judging from their fresh-

ness and the intireness [?] of their medullary cavities to contain most of their original properties possessed the least were not at all altered by the fire, no more than stones or calcined bones but the {effect} {impression} was different on the teeth remains from the other chambers—it caused them to effervesce and crackle to intumesce and decrepitate, throw off a dark flame attended by a strong smell of burnt bones, most observable in Rhin^a bones. The {solid plates of enamel} {inner and outer case} had served as a sheath in protecting the central layers of the bone from decay.

The other bones blackened like ordinary calcined bones and crumbled to a cinder—These bones contain therefore considerably less of animal gelatine, tho to the eye they appear better preserved than the bones of the Irish Elk of which they make bonfires in Ireland

The remains suffer by exposure—become arid and adherent to the tongue the large bones split longitudinally under the action of the sun. The outer laminæ of the teeth first, swell, then divide into lozengeshaped pieces and exfoliate. In the sun they fall to pieces—a thin solution of Isinglass and gum is a good preservative against the effects of exposure.

Fracture

[134]

The hard bones of the tarsus and metatarsus of the several animals generally escaped untouched. There were however a few specimens so mutilated and gnawed as scarcely to be recognizable—and how little even the smooth bones of the astragalus were respected deep grooves and scratches traversing their surface testify—and they are constantly fined off at the edges, which is the case with all those teeth remains which are too hard to be broken and devoured.

Flints

[135]

Among the multiplicity of substances associated with the animal remains the occurrence of flint and chert in different forms claims separate and particular consideration—

They are of three sorts—

1 The first are about an inch long, {fined} {chipped} off at the sides, and pointed at one end—They appear to have been used as arrow heads spear and lance heads cuneiform—about a dozen of these have been found—no doubt many more escaped observation from their minuteness.

There are a few specimens formed with great art, sharp

pointed sloping and barbed—of which fig. * * *† is a good example—

2 The second variety consists of oblong doubled-edged splinters plain on one surface but raised on the obverse, a central ridge traverses the length, the remains of the planes from which the tranchant edges of the sides have been sliced off—truncated at their extremities.

They vary from two to three and a half inches in length and are generally $\frac{3}{4}$ of an inch in diameter—

There is also of this description a still smaller size—not much larger than the blade of a pocket knife—but in all respects similar to the large ones—

This species seems to have been employed as knives or chisels for dividing and shaping wood and exhibit the marks of wear on their edges

- [135a] Sir R. Hoare found two rude arrow heads of flint near the head of a skeleton and a drinking cup at its feet (Part 2 P. 104),† in a barrow in the vicinity of an ancient British village, on an eminence known as Whiten-hill—Fossil cockle shells—petrified wood—pebbles perforated for which the Britons had great fancy ascribing certain virtues to them, viz the snake gem supposed to be produced at the tail of a serpent being generated serpents by the breath of many serpents§

Sir C. Hoare found in the Amesbury Station the skeletons of 2 dogs||—so did I near the beads

- [136] The third kind are oval shaped disks chipped round to an edge—from two to $3\frac{1}{4}$ in. across, and some of them diminished to a point, like wedges. This part in these specimens was observed to be blunted apparently from knocking like a hammer against hard bodies—while the sides, which in such an operation would not be used, still remained sharp—They are obtuse and massive on one side, but sliced to an edge at the opposite—capable of acting as wedges and axes in splitting wood or of striking off the smaller splinters of flint from the blocks

I have found several splinters of limestone and bone of precisely the same shape as the 3 above, but being of less durable material are not as well preserved—

The generality of the three species are invested with a chalky coat resulting from decomposition of the outward

† [Not figured in any plate known to me. W.P.]

‡ ["South Wilts." W.P.]

[See Sir R. C. Hoare's "South Wilts," p. 120. W.P.]

|| [Ibid. p 125. Sir R. C. Hoare's words are "the skeletons of two dogs, as we conjectured, being deposited in the vegetable earth, they were much decayed." W.P.]

laminæ—in a few specimens the siliceous matter has totally disappeared even from the core only the residuum of the phosphate of lime remaining—at their transverse fracture they are porous and absorbent adherent to the tongue like the fossil bones and support their weight

A good many have however escaped with only partial modification of their substance—one extremity has retained its properties, while the other has suffered change—one of the knives the late Mr Philips the eminent mineralogist considered to be formed of siliceous schist—It {does not possess} {wants} the conchoidal fracture of flint—and moreover exhibits minute specks assumed to be Chlorite, is translucent at the edges but Dr. Buckland pronounces it to be black jasper. Sir R. Hoare mentions in P. 79, 1 vol. of An. Wilts—black stone celts or battle axes† very likely of the same material.

Uniformity of Fracture on the Flints.

[138]

In reviewing this collection of flints you are first struck with the uniformity of size as well as structure distinctly observable in the individ^l specimens constituting the three species—every chip being referrible to some one of the 3 classes specified—In this respect they differ from the splinters in the great deposits of flint nodules of Haldon and Blackdown from which the nodules came, which I examined, no two of which were alike—but the regularity of their fracture precludes the possibility of these cavern splinters being produced by accidental collision with other substances—and even supposing this to be the case, the remaining chippings and nodules would be found as well as the pieces which are designated flint knives—but it is curious that flint occurs under no other form than in those just enumerated—but their {artificial} {mechanical} origin is placed beyond all doubt by the discovery of analagous splinters in Mexico accompanied {with} {by} cylindrical blocks from which they were derived—The longitudinal planes of one surface and the sliced edges of the other precisely correspond with the raised surface of the parent block—from one of which Mr Chantry has struck off splinters in no wise distinguishable from the articles in question—the only difference between the Mexican and Cavern blades consists in the material—the Mexican being fabricated of obsidian, the cavern reliques of flint, chert, and jasper—By the kindness of Mr Sloper who presented me with one I have been able to compare the latter

† [South Wilts, p 79. W.P.]

with his collection—both knives were uniform and bore evidence of having been produced by a similar process as ascertained by Mr. Chantrey's experiment—

- [137] Mr Hibbert is of opinion that in the Orkney Steinbarts or stone axes traces of the mounting are discoverable.† he conceives that they were inserted in wooden or bone hafts and fastened crosswise with overlapping thongs formed of the dried sinews or entrails of some animal—An analagous specimen to that fig. in Brew. Edin. Journ.‡ and restored to what was probably its original mounting has been found in Kent's Hole—and it is curious as confirming his conjecture of the mode of using these axes that the cavern flint is blunted at its opposite ends like a hammer while the edges of the sides are not at all worn—

- [138] Their fabrication and introduction of man being thus established Similar reliques have been traced in the * * * and in the barrows

[140]

Different Localities

Flint knives, Steinbarts or Stone axes have been found in Shetland, in the Orkneys, improperly called celts, a term of great latitude commonly applied to warlike Instruments found among people as En[glish], Scotch, German, Welsh, Gaelic, from Celtæ supposed to be the aborigines—but which Dr. Percy [in the historical essay prefixed to his translation of Mallett's Northern Antiquities, referred to by Dr. Hibbert] has shown that this designation should be changed into Teutonic of the several nations as Scandinavians Anglo-Saxons—Notur in his notes on Tacitus states that pointed stones have been discovered in the German sepulchres—(Oct. 1824, Hibbert—Brewster's Journ^l [pp. 306-9])

Nor is it an uncommon thing to find arrow heads of flint in the ancient cairns of stone in our own country (Gough. Sep. mon. Vol 1. P. 18)§

Flint heads for both spears and arrows are frequently found in England, Scotland and Ireland—Groses Mil. Antiq. Vol 2. P. 275.

Lieut Col. Vallancey in his Collectanea gives a delineation of a spear head of flint found in Ireland.—

† ["Remarks suggested by the Resemblance which certain ancient Stone Axes found in Orkney and Shetland bear to those which have been found near the Humber." By Samuel Hibbert, M.D., F.R.S.E. The "Edinburgh Journal of Science," vol. i. pp. 306-9, 1824. W.P.]

‡ Ibid. Plate 9. Fig 3. W.P.]

§ ["Sepulchral Monuments in Great Britain," &c Part 1, Introduction, p. xviii. W.P.]

Barbed arrow heads made of particolored flint are frequently picked up on the moors near Durham—They are called Elfbolts (Outlines of Geol.)

In Druidical barrows in Somersetshire and Wilts opened by Sir R. Colt Hoare and Mr. Miles were found flint arrow heads and knives, along with sepulchral urns and Kimmeridge coal money—Sir R. C. Hoare *Antiq. of Wilts.* Miles *Meinor*—The figures of the flint celts delineated in Plates 5, 6 are equally just representations of those from the cavern—both species of *white flint*

They would seem to have been used by the Saxons as appears by an extract from a Teutonic Romance of the eighth century “Then the first let ashen spears fly with rapid force that they stuck in the shields—then they thrust together resounding stone axes.”

They occur near the Humber, and in Warwickshire and in different forms. The blade of one found in England and described by Whittaker in his history of Manchester contains an orifice calculated to admit within it a wooden haft†—but there is no orifice displayed by the blades from the cavern. There are transverse indentations in one or two, as if for the purpose of more effectually securing it in the arrow.

Cabinets of England and France

[142]

I have identified the flints with similar relics preserved in different museums both in England and France—those especially which are in the British and in the museums of the Jardin de Plantes and of Boulogne sur mer—

First use of Flints

[143]

From the occurrence of these uncouth instruments in widely distant regions it would appear that the barbarous aborigines scattered over the globe left behind these memorials of their primitive inventions in their early settlements—It was but natural for a people unacquainted with the use of metals to seize the first hard substance which offered to their hands and apply it to hewing wood, shaping and mounting their arrows and such like instruments of savage life—

In progress of time they would learn to {choose} {select} the hardest substances such as flint, chert, or obsidian and experience would teach them to adapt them to the present form of arrow and spear heads, knives and axes—but though their necessities might have taught them to shape their

† [The History of Manchester. By the Rev Mr. Whitaker (1773), vol. i. pp. 20–21. W.P.]

instruments to their wants, the extraordinary uniformity visible in those collected in different parts of the earth could only result from a common method learnt by these different nations previous to their migration into distant climes—and would go to indicate the common origin of the first colonists of the earth—

Grose is of opinion that these flints were the first rudiments of our instruments of war—"The spear, or lance, is among the oldest weapons recorded in history, and is nearly coeval with the sword or bow, and even seems a much more obvious weapon than the latter, probably originating in a pole or stake, sharpened at one or both ends, afterwards armed with a head of flint, and in process of time, on the discovery and use of metals, with copper, brass, or iron."—*Mil. Antiq.*†

The anc^t Inhab of Britain formed of basalt the heads of their battle axes, commonly called Celts—they resemble in shape the tomahawks found in the South Sea Islands—*Conybeare Geology*—

And Herodotus (*Polymnia*) relates that the arrows of the Ethiopians were pointed with a sharp stone which they used to cut up their seals with"†—and the Ancient Germans generally prefixed pointed stones to their weapons. (*Grose Mil. Antiq.* P. * *) and even so low as the conquest of South America, hatchets and wedges of stone heated by fire were employed in felling wood—and by casting in red hot stones into trunks of trees they excavated and modelled their canoes and cauldrons of wood for cooking. *Rees Ency. America*—

- [141] Flint and other *Pebbles*, oval and circular, from a pigeons egg up, of flint, sandstone &c were most probably used as missiles in slings. They are abundant in the barrows, most ancient Celtic sepulchres. The circular flat stone found in Berryhead Cave was used probably for the same purpose—(the perforated one for a bead, as also that from the clay of the upper branch of Kent's Hole).

[151]§

Position

Having described the form of these singular flints and

† [*Vol. ii. pp. 274-5. W.P.*]

‡ [The passage in Herodotus here referred to by the author is thus translated by Mr. Cary:—"The Ethiopians were clothed in panthers' and lions' skins, and carried long bows, not less than four cubits in length, made from branches of the palm-tree; and on them they placed short arrows made of cane, instead of iron, tipped with a stone, which was made sharp, and of that sort on which they engrave seals."—"*Polymnia*," c. 69. p. 436. Bohn's Ed. W.P.)]

§ [Pages 144-5-6-'7-8-9-50 are occupied with miscellaneous memoranda, which will be given in *Fasciculus J.* W.P.]

pointed out their analogy with similar reliques discovered in the sepulchral monuments and habitations of the first settlements of the aborigines of the different countries in which we traced them, it is our next duty to state the position they occupied in the caves under consideration—

Excepting the solitary instance of their occurrence in the disturbed shingly covering of the loam, in the higher Division to which we have already adverted their uniform situation is intermediate between the bottom of the stalagmite and the upper surface of the loam forming a connecting link between both—one extremity has been generally found {encased} {inserted} in the loam, the other protruding upwards into the stalagmite above. I possess two examples of this description.

From its immediate contact with the crust, the under bed is indurated to a breccia including bony and rocky fragments, in the centre of which the lower end of the stone axe is frequently seated.

Lower depths of knives.

[153]

They have likewise been found, tho rarely, at a still lower depth dispersed irregularly thro the loam promiscuously with the other {materials} {relics}—and from the fact of detached pieces being found at distances apart from their corresponding portions it would at first view seem that they were {subjected to the same} {suffered a similar} movement as the bones, concerning which this remark has been already made—other solitary portions of flint knives of which the remaining parts could not be recovered have been found in the same circumstances—of this description also I possess half a doz. specimens, some of which are still encased in with indurated loam mixed with spar—but the greatest depth that I have been able to trace them down has been no more than a few inches below the surface of the mud thro which while it was yet in a state of fluidity they sank down—They have never appeared so low as the substratum of rubble—

On the other hand it is {curious} {singular} that they never have been traced upwards in the direction of the surface, tho under similar circumstances situated like the charcoal and Deers bones of later accession at various depths in the stalagmite—and still less have they disclosed themselves in the loose modern mould on the floor of the stalagmite—but almost invariably repose in the intermediate space between it and the region of Diluvium partly attached to both—yet holding no absolute connection with either farther than the casual circumstance of contiguity and contact—

- [155] Hence the natural and inevitable inference is that antecedently to the superimposition of the {plate} {conglomerate} of stalagmite they lay partly exposed on the surface of the loamy sediment and that owing to its soft if not fluid state, some of them sank down thro it to their present situations or from some artificial cause such as the excavation of pits or ovens in the loam scooped out for the purpose of cooking game they were dropped into them and the loam turned over by those who sat round preparing their weapons for the chase or dividing the carcasses of their prey.

The occurrence of bones in the same position smoked and calcined {bear evidence of} {strongly support} this conjecture and still higher up interposed in a seam about the middle a few inches in the incumbent crust of stalagmite, charred bones of Hog and Deer enveloped in carbon have been dug out—pieces of charcoal and mould—which were the first and earliest vestiges of of the visits of man.

Remark

At the wings where the crust consists of pure and stratified spar unmixed with stones or foreign substances they have not been yet traced—It is only in those places which bear evidence of disorder and increasing accession of extraneous matters superimposed on their surfaces that they are to be met with—e.g. the lobby—Dome—upper Section—

They occur in greatest abundance near the common entrance—in the space of a few feet about fifty of all sizes were found—The proximity to the light naturally led to the choice of this passage—

- [157] And it will follow as a corollary from this view that the cave was almost instantly visited posteriorly to the introduction and subsidence of the loam and before the new superstratum of stalagmitic floor—for unless interrupted by the intrusion of man, as was observed to be the case in the Bears den, the progress of encrustation would have immediately commenced and glazed over the surface of the loam before the insertion of the instruments of flint—

The epoch of the introduction of the knives must therefore be dated antecedently to the advance of the stalagmite—from the era of the quiescent settlement of the mud—

I had taken this view of their position and history some years ago—I have employed the interval in carefully investigating their locality—I first discovered them mixed with Human bones in loose carbonaceous mould within half foot of the surface near the mouth—the crust had been broken up

and its remains were visible in flakes scattered through the mould—when we descended about three feet the loose black mould gave place to a firm bed of a dirty red color the surface of which displayed the singular phenomenon of flint instruments intermingled with fossil bones!—about 1 foot lower down they disappeared, but the fossil bones continued constant to the red marl—Thus far their existence in the present state of the cavern was determined—Still the difficulty remained unsolved—viz. whether the flint did actually occur under the unbroken floor of stalagmite—and whether they [158] originally coexisted before their position was invaded—In this spot the crust was confessedly disturbed and removed—and in the other localities, tho there was no doubt of their existence under the crust and touching the mud, there was still a doubt whether the crust had been dug thro for ovens and pits the stalagmite in those places assuming rather the character of a conglomerate, than a regularly stratified bed—but now there is no longer a question of their actual presence under the stratified, unbroken floor of stalagmite—All along the lobby like passage it has been already remarked that they abounded but under ambiguous circumstances—it now became imperative to continue on excavating towards the end till we should fall in with the crust at its undisturbed point and we succeeded—its sharp edge appears about * * * feet from the entrance at the base of a flat rock—accurately compared with that of the excavation made farther in near the end of the lobby—it presented precisely identical characters. Having cleared away on all sides the loose mould and all suspicious appearances, I dug under the regular crust—and flints presented themselves to my hand—this electrified me—I called the attention of my fellow laborers (Master Aliffe) and in his presence extracted from the red marl arrow and lance heads—I instantly proceeded to the excavation inside which was only a few feet distant in the same continuous line and formed part of the same plate—the crust is about 2 ft thick steady, the clay rather a light red—about 3 in below the crust the tooth of an ox met my eye—I called the people to witness the fact—which I extracted before M. Aliffe—and not knowing the chance of finding flints I then proceeded to dig under it and at about a foot I dug out a flint arrow head. [160] This confirmation I confess it startled me—I dug again and behold a second—of the same size and color (black) I struck my hammer into the earth a third time, and a third arrow head (but white) answered to the blow—This was evidence beyond all question—I then desisted—not wishing

to exhaust the bed—but in case of cavil, leaving others an opportunity of verifying my statements by {digging themselves} {actual observation}—I said the tooth of ox occurred about 3 in—the envelope light red—it continued so till we joined the flint bed—Here a darkish and crumbling layer about * * * thick ran round the excavation—bits of charcoal, still were visible—the bed emitted a disagreeable smell—pieces of branches were still distinguishable by their knots—This is the region of the flints—Here they were deposited before the addition of the plate above—most probably at the same epoch with those nearer the mouth above which the crust {was stated to be removed} {formerly extended}—and also with those in the great chambers, where it has also been stated they occur under stalagmite, but less homogeneous and regular—Hence it results that the flints at the extremity of the lobby were deposited in their deep position before the creation of the stala., by the primitive nomads, and that those nearer the mouth were similarly circumstanced—i.e. overlaid by a laminar plate which was after a long interval of time (that admitted its increase? to * * * *) stripped away to make room for the habitation of the living and inhumation of their dead—In all the Wiltshire Tumuli it is invariably remarked that a cist or species of coffin is cut into the bottom of the chalk bed for the reception of the body, which is found [161] with its legs under the thighs with face to the East—an urn generally reversed reposing under its head, or placed on its breast with an elegantly indented and beautifully shaped cup of small dimensions (supposed by Sir R. Hoare to be a drinking cup) situated at its feet—arrow and spear heads of flint axes of black stone or Sienite are sometimes found and articles of dress and ornaments fashioned of bone

Here all along this passage a similar interments were evidently made—In the Wilts tumuli there are occasionally found two or three successive depositions—the first cut in the chalk—the flints and other circumstances are clear indicia of the infancy, poverty and rudeness of the people—This agrees with the *lowest* locality of flints in the cavern, overhead it is a found a second burial with more elegantly fashioned flints, celts, breastplates of gold, beads of copper and tin, and clay—wellshaped baked pottery indicating greater perfection in the art. This interment answers to the second in the cavern, made in the pits of stalagmite when everything declares the [162] advance of civilization—such as the more elaborate pottery, Celt axe of Sienite, pins and bodkins and spearheads of bone—the screw ornament of copper—piece of silver breastplate.

Thirdly came the Romans recognizable in Samian pottery, of a fine earth—turned on a lathe—exquisitely figured and glazed—

These three Epochs are marked by simple and distinct lines which it is impossible for an unprejudiced mind to mistake. They are uniform and universal throughout the cavern, but owing to the stalagmite taking a more stratified and unobjectionable form in this branch the evidence is most clear and irresistible.

While I incline to the opinion of the Post diluvian origin [159] of these flints, I feel obliged in candor to state the ground which would seem to countenance the opposite Hypothesis.—as exhibited by the circumstances of the knives.

1 The actual residence of the flints at the stated depths in the Diluvium mingled confusedly among the bones. The excavation of pits or ovens or other evidence of the Post Diluvium visits of man

(Answer)

The existence of the burnt bones is a sufficient answer to this difficulty, and had they been left by man on the antediluvian floor with the fossil bones by Hyænas they would have been found at the lowest as well as the highest situations.

2. The analogous circumstances of the knives and bones, The dissevered portions of which lay apart from the corresponding parts as if they had been drifted forward from their original position simultaneously—and this circumstance furnishes a presumption that like the bones they had lain exposed on the floor at the time of the ingress of the mud—To this it may be replied that those who fabricated and used these flints may have also broken them and cast the fragments away.

3 Their existence in indurated masses consisting of decidedly antediluvian or diluvian materials, viz. fossil bones and rolled pebbles—

To these objections one simple answer will apply, that in the case of their being similarly circumstanced with the bones, they should be expected to be similarly affected as the bones and carried down to the lowest regions of the loam [161] like them, but we have seen that they have never been observed there but invariably at or near the top of the loam—and surely their greater gravity would have had a less chance than the bones of being floated up to the surface—

And even if they had lain exposed on the floor along with the bones they could not have escaped uninjured as we find

them, but from their offering greater resistance than the yielding materials to the rocky fragments set in motion by the impetuous movement of the mud would have been found crushed to atoms, in place of being with one or two exceptions entire—

- [163] With respect to the question, implied by the antedil. origin of these flints, of the occupation of this and the neighbouring Caves by antediluvian man it may be observed in the first place, that the absence of human remains in all undisturbed deposits of fossil bones referrible to the deluge furnishes a presumption against the anomalous appearance of Kent's H.
- [162] Admitting that is [? it] was fully established that instruments of art occur in the midst of the bones in places to which we see not how they could have arrived by any post-diluvian operation, Dr. Buckland considers such a fact would go to supply a link in the chain of evidence which has been hitherto a desideratum of no small magnitude, namely that man in a savage state inhabited England before the Deluge.
- [163] And it may be added that the existence of man seemed incompatible with the vicinity of the enormous multitudes of ravenous wild Beasts which swarmed through the surrounding plains, filled every rock and retreat and at their death contributed their bones to the heaps in the cavern—and even admitting the unmolested existence of man it may be asked how it was possible for him to obtain access to, and quit an habitation (the presence of such numbers of his weapons diffused thro the interior Cavern prove that his visits were not transitory) proved to be divided between the Hyæna and Bear, as a den, through successive generations—and if we even allow not only his existence but actual presence in the Cavern at the period preceding the deluge, we naturally look for his bones—Some relic of them w^d have descended to us with those of the animals which preceded or followed them—surely where the strongest and most ferocious have fallen victims of each others violence man would not have been respected—and applying the analogy of the modern Hyænas habits of exhuming the Dead in Turkish cemeteries, to the antediluvian would have sought and dug out the bodies of the antid [iluvian] dead and drag^d them piecemeal into his common repository along with those of every creature, of
- [165] every species and age which fell within his range.

The Hyænas of Kirkdale, says Cuvier,† have not accumulated Human bones with those of so many Herbivora crowded

† [See "Recherches sur Les Ossements Fossiles. Par M. Le D^r. G. Cuvier. Nouvelle Edition, 1823. Tome Quatrième. p. 395. W.P.]

into this den—It was because they found no man in their neighbourhood living or dead—nor can a single reason says Cuvier be assigned why men should have entirely escaped from the Catastrophes which destroyed the brute creation—and why their bones should not have been found like theirs—

Nor is the absence of human bones attributable to their greater tendency to decay than other bones, both similarly circumstanced. From the exhumation and analysis of bones in the ancient church of St Genevieve interred below the first race which may even have belonged to some Princes of the family of Clovis and which retained their forms perfectly * * * dynasty of France interred during a period of 900 years it has been ascertained by Cuvier that they are not more perishable than those of animals.†

In Egypt no difference is observed between the mummies of men and those of Quadrupeds

“We do not find in ancient fields of battle, that the skeletons of men are more wasted than those of horses, except in so far as they may be influenced by size; and we find among extraneous fossils the bones of animals as small as rats perfectly preserved.” Theory of E. P. 129—[130]

All the bones of our species that have been found have occurred accidentally and their number besides is exceedingly small which assuredly would not have been the case if men had then been settled in the countries which these animals inhabited.

But to this Dr Buckland replies that he possesses a human [164] bone from Kents Hole, but is uncertain as to its precise locality—nothing defined consequently can be inferred from its discovery—

I too have found human bones near the mouth—accompanied with pottery, shells and an ornament made of bone—They were entombed in a pit excavated in the surface of stalagmite, indicating comparatively modern sepulture—probably about the time that the skeleton in Paviland cave was inhumed—but in the decidedly diluvium deposit, no human tooth or bone has revealed itself—over and over again have I {examined} {reviewed} at my leisure every individual tooth and bone of my immense collection, it could scarce elude my search, we may then conclude there is no trace of the coexistence of man in this country.

From all which it may be collected that man did not at the [167] epochs alluded to, coexist in this country with the animal population and that the latter held sovereign and undivided

† [See “Theory of Earth” § 32. W.P.]

dominion over the tract above and the regions beneath—and that from thence and the different circumstances of the flints in the loam we are justified in concluding that these instruments owe their introduction to the era when the wild tenants of the woods and caves ceased to exist and were inhumed in loam and succeeded by savage man in the possession of both—and that this transfer of dominion took place immediately after the events specified is inferred from the position of their weapons above and in the surface of the loam previous to the advance of the crust—and that man consequently became the allocated inhabitants of this region immediately after the deluge which is assigning him a higher antiquity in this country than has been hitherto allotted—

[168]

Objection
Drifted in by mud

It may be asked may not they have been drifted in by the mud? Such an impetuous movement as was necessary to convey the accompanying materials into the cave would have shivered the long delicate knives to atoms and would have at least rolled the larger axes—but the case is the reverse—these frangible substances are preserved in all their sharpness of outline—the finest as well as the grossest—those that appear at all rounded, are at their opposite ends from wear—but their sides are unworn—it is therefore not attributable to agitation in a fluid—and we have seen that their introduction was caused by the same movement that drafted in the loam and rocky fragments.

[169] But Dr. Buckland is inclined to attribute these flints to a more modern date by supposing that the anc^t Britons had scooped out ovens in the stalagmite and that through them the knives got admission to the diluvium, and that in this confused state the several materials were agglutinated together in the manner of the mass containing the flint axe—

Without stopping to dwell on the difficulty of ripping up a solid floor which notwithstanding the advantage of undermining and the exposure of its edges, still defies all our efforts, tho commanding the apparatus of the quarry I am bold to say that in no instance have I discovered evidence of breaches or ovens in the floor but one continuous plate of stalagmite diffused uniformly over the loam—and that along the {inclined planes} {declination} of stalagmite in the sloping chamber composed of constantly accumulating rocky fragments precipitated from the upper eminences, no trace of the excavations alluded to at any stage of its growth was visible

above the {bed} {locality} of the flints—and if the remains of these ovens were to be found clearly defined in any place it would surely be where the crust is free from admixture consisting of {pure carbonate of lime regularly laminated} {a soft fleecy congelation or utterly white substance}—Within half a foot of the top of this bed, as has been already observed, a thin seam of dark mould has been traced—in this mould were found burnt bones and charcoal—but they are not lodged in an artificial hollow in the stalagmite but simply [171] repose on the pre-existent stratum of stalagma which {separated} {parted} them from the diluvium—in the situation of substances deposited on a gravestone and subsequently overlaid by a similar slab—discovering no visible connection with the inhumed remains below

I have dug nearly away the seam—it is within three [168] inches of the surface and formed the passage into the arcade—it consisted of external mould such as is every day brought in by visitors small polished pebbles of white flint and shells—more in the centre there was remarked a layer about two inches thick consisting of smoke colored bones of Deer—accompanied by two jaws of Hog exceedingly fresh and strongly contrasting with the other discolored bones The bones of rabbits and Rats occurred in the same bed—these various substances lay imbedded in a * * * * of charcoal and burnt straw—

The smoke colored bones appear to have been roasted on a fire of which the charcoal is the remains—The jaws of the Hog had not been dressed—

The depth of the cover of crust corresponded with that in the Bears den and the bones of Hog, charcoal and shells are of the same description as those found with the spear head, mutually explaining and connecting their respective anomalies, and are referrible to the same era, when the people of that day hunted Deer and Boar and launched the spear in the chace—

The only vacuum observed during our workings was caused [171] by irregularly piled masses from the roof extending like bridges across the diluvium or crust, generally lined with a waving crust and the Foxholes.

I have more than once adverted to the occurrence of flints in the upper Division under what has been deemed questionable circumstances. In describing the floor of that cave I dwelt upon its disturbed condition arising from the operation of foxes in throwing up loose loam, and the occasional falling of masses from the roof—

This loose loam besides the fossil bones, exhibited heaps of Fox dung, and heads of Dog and Badger—In the midst of which were seen the beads and Cylinders and pottery and copper already noticed—an accumulation of these materials interspersed with rocky fragments the whole indurated to a [172] breccia constitutes the covering of the Diluvium of the depth of 3 feet—In this superficial bed I have detected Flint relics and I have been assured by a Rev^d. Gentleman that he has found them in great abundance there—but on the occasion of Dr Bucklands last visit we were not so fortunate as to find even one notwithstanding the removal of large masses of this bed, by the Rev^d. Gent. himself and the rest of the Party—

In the same manner as a straggling fossil tooth may be traced in it, so a casual flint may be dug out—but certainly not in abundance—The excavation in question after great labor, I first opened and carried on to its present state—not a shovel of stuff modern or ancient that I did not examine—and my experience would have surely enabled me to decry them if they occurred in such quantity or in any quantity—and the circumstance of finding the cylinders and pottery made me more than ordinarily attentive but the result of my excavation of an area of square yards was one flint in the disturbed bed—and the spear head (fig. * * *)† and few knives in the virgin loam—which is not a greater proportion than the other branches supplied.

[173] But the number is of trifling importance compared to the fact of their occurrence in a modern heap—but we have already seen that this heap also contains part of the materials of the diluvium viz. the loam and bones and that these knives were thrown up from the lower deposit is rendered certain by the occurrence of similar flints, and in still greater abundance in the region of the loam which contains Diluvial materials exclusively like that in the other localities of the flints—If they had been found only in decidedly modern mould or even of mixed character there would be an end of the controversy—but the fact of their occurrence in the lower bed in still greater number than the upper, sets the matter at rest—

No argument therefore of their modern origin can be drawn from their presence under the circumstances alleged—It has been proved that the bed which contains them consists of heaps of diluvium thrown up from excavations of badger and foxes and mixed with the detritus of the roof and articles left there by man. In confirmation of this view I may

† [Perhaps in Plate T, "Cavern Researches." W.P.]

add that this is the only modern l[ocal]ity† throughout the range of caverns where they are to be met with—Even in the modern bed in the Bears den no flint knives have been found, though fossil teeth were discovered with the blade of iron which shows that they * * * † epoch—

In relation to my statement of a continuous crust pervading [170] the surface of the diluvium Dr. B[uckland] observes that the fact of an unbroken crust of stalagmite over any given spot in which a knife has been found is not decisive to show that the Dil[uvium] at that spot had not been broken into at some early Post dil[uvian] period and subsequently sealed over. The H[uman] skeleton in Burrington Cave in the Mendips was buried under four or five inches of stalagmite‡—In most cases he contends the advance of the crust is progressive either from a centre spreading circularly in all directions, when it enters by dripping from the roof or forming papillæ on the floor—or laterally progressive when it oozes thro the sides of the cave and spreads transversely or longitudinally according to the inclination of the surface, but in all cases it is progressive—Its extremities are thin, its parts nearest the source of infiltration thickest—a spot that is now covered by the march of these encrusting waters may have been open to receive impressions from the hand of man, before the advancing and encrusting fluid arrived so far—To this just dissertation I may add in illustration—the fact that groups of bones in German caves which the stalactites formerly respected may be seen gradually disappearing under the accretion of them (Jamies. notes on Cuvier)§

When the floor is a horizontal plane this description obtains—but in inclined and rapid slopes, the concreting matter flows down and accumulates at the foot against the opposing wall. This is the case in the sloping chamber—the parts at the base which produced the knives must have been consequently the first overspread—and from the constant addition of roll[in]g masses the covering of the diluvium at this point was thicker than in the upper part. The calcareous fluid which formed the undulating pavement along this chamber was not derived from infiltrations dropping from the entire surface of the roof but from the central masses of the stalactites and lateral ducts or cascades The union of these lateral and vertical streams diffused a plate of stalagmite low down near the wall of the cave where there is no issue from the

† [Part of the page has been torn off here. W.P.]

‡ [See Buckland's "Reliq. Dil.," p. 164. W.P.]

§ [See Jameson's 8th Note to Cuvier's "Theory of Earth." W.P.]

roof above. It is painful to dissent from so high an authority and more particularly so from my concurrence generally in his views of the phenomena of these caves, which three years personal observation has in most every instance has enabled me to verify.

[END OF FASCICULUS C, with the exception of the Miscellaneous Memoranda. W. P.]

[FASCICULUS D.]

FLINTS. VID DISCOVERY NEAR THE MOUTH. [3]†

THUS have I given the result of long and anxious investigation of the circumstances of these curious relics—It cannot be urged that I have been from the commencement indifferent or inattentive to their localities—the circumstance of my discovering one on the occasion of my first visit with Dr. B and Mr. Northmore forcibly called my attention to them—and ever afterwards directed it to the examination of their situation in the ground. Nor can it be with justice objected that in my present explication of this anomaly I have been influenced by a {desire} {ambition} to advance or support a favorite Theory—Those from whom I have the misfortune to dissent on this subject are aware of my reserve and repugnance I long showed to admit their artificial origin—the clearest evidence exhibited by the uniformity of their shape and fracture, and thus differing from natural flints, and their I had almost said identity with the Mexican and Druidical Reliques determined my assent—From this period more especially, March 1827—I attached still greater importance to their presence, carefully cautiously and deliberately scrutinized and noted their localities, and looked for fixed and settled grounds for building my opinion upon—but this evidence is not perhaps yet complete—future inquirers may hereafter light on some more decided document to define their epoch—

Common Origin of the Postdil. Colonies. [4]

But perhaps sufficient has been said to demonstrate their general conformity with those discovered in barrows and other monuments of the early inhabitants of this Island—The circumstance of their being of ruder workmanship than the sepulchral relics, viewed in {connexion} {concert} with other particulars just dwelt upon, inclines us to refer them to an earlier date—to the progenitors of those Celts who founded the barrows, and along with the ashes of their dead inhumed these records of their savage life in urns—but however divided

† [The author designated this Fasciculus "No. 3." From its "Index" it commenced with page 3. W. P.]

opinion may be on this point, it is scarce possible to deny that the people who left them in the caves and barrows in Britain, were accustomed to frame and use flint weapons similar to those employed by the aborigines of Germany, South America, and Ireland—and from this similitude of habit it may follow as a corollary that these different nations were probably colonies from the same common stock, which after the catastrophe of the Deluge, migrated into distant regions to repeople the earth, and this view coincides with that of Cuvier.

Inferences from the Organic Remains in the Strata.

I agree with Cuvier and Buckland, who themselves follow M. M. De Luc and Dolomieu, in thinking that if anything in Geology be established it is that the surface of our globe has undergone a great and sudden revolution, the date of which cannot be referred to a much earlier period than five or six thousand years ago; that this revolution overwhelmed and caused to disappear the countries which were previously inhabited by man and the species of animals now best known†—

That it is since the occurrence of this revolution that the small number of individuals dispersed by it have spread and propagated over the newly exposed lands and consequently that it is since this epoch only that human societies have assumed a progressive march, that they have formed establishments, raised monuments, collected national facts and invented scientific systems. (Theory of E. 239)‡

But the countries which are at present inhabited and which the last revolution laid dry had already been previously inhabited if not by man, at least by land animals, and therefore one preceding revolution at least had put them under water; and if we may judge by the different orders of animals the [5] remains of which are observed in them they had perhaps been subjected to two or three irruptions of the sea. (Theory of E. 240)‡

The surface of the globe offered but the hollows of rocks for their habitation, or at most, insecure hovels inferior to the ample accommodation of these sequestered retreats. Into these hollows or caverns the first visitors entered and dropped their arrows and spears—and their Posterity interred their dead here in urns accompanied by the usual circumstances of

† [This passage is an almost verbatim copy of a passage from Buckland's "Vindiciae Geologicae" (1820), p. 24, where it is acknowledged to be copied from Cuvier's Theory of the Earth, § 34. W. P.]

‡ [See Kerr's Cuvier's "Theory of Earth," § 34, p. 171-2. W.P.]

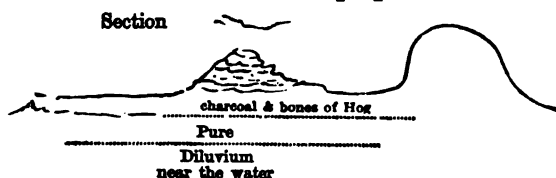
Druidical interment,† the remains of which agree in the quality of the material and the figures of the moulding with the reliques of the Deveril barrow, situated between Whitchurch [?] and Melbourne [?].—The circumstance of finding a piece of copper associated with the pottery and of cylinders of clay slate both of which substances have been found in the Druidical barrows

As analogous with the position of these flints may be [6] adduced the discovery of shaped wood under lava associated with several species of Quadrupeds including the same variety of Bear *Ursus Cultridens*

This phenomenon occurred under the lava of the mountain of Boulade, in the neighbourhood of Issoire in France—superinduced over diluvium consisting of the rounded fragments of different strata—there are no traces of the Human body—the same anomaly has been remarked in the adjacent mountains, especially in that of Bouteresa, which is not far from Bantida [?].—pieces of wood have been discovered, buried under the ancient lava exhibiting the marks of fashioning by the hand of man—and to have been hewn with a hatchet, altho rudely and as might be expected in the infancy of the arts—Scropes Geol. of Central France.‡

In the commencement of our search for bones a piece of wood was said to have been found in the Diluvium below the crust along with the bones—but as it was found by an inexperienced person it is more probable that it fell from the top which was covered with a quantity of common mould, and wherein I detected myself a rudely shaped piece of wood now in my possession.—In two or three instances fragments of branches were noticed in the diluvium—and spots of carbon, but in no case artificially shaped wood.

Nor was the Cavern altogether deserted during the long [7] interval of the forming of the crust—insulated spots and seams of charcoal mixed with burnt bones still attest the successive visits of an uncivilized people—



† Chevron or zigzag markings were the favorite figures on the pottery and ornaments of the Britons and Egyptians and subsequently of the Saxons—The same are observable on ancient Greek vases according to Dr Clarke.

‡ [After a careful search, I have failed to detect either in Scrope's "Central France," or in the review of that work in the Quart. Review, vol. xxxvi., pp. 437–483, any mention of *shaped* wood under lava. W.P.]

Next came the people who buried in this place their arms, beads, coal money and shaped ornament of bones—(spear heads of bone)

And after them it became the resort of a civilized people who transmitted a finer pottery, the blades of wrought iron in the Bears den, and the barbed spear-head in the secret grotto near the Vaulted mouth, agreeing in their circumstances with the Ro[man] remains in the caves of Anstis Cove and Berryhead, and like them referrible to the roman settlements in this district—

Then follow inscriptions on Inscriptions successively overlaid by infiltrations—down to names in the 15th century which may still be deciphered—but with the preceding characters are fast retiring behind a veil of stalactite—

The fact of inscriptions of so remote a date still remaining unobliterated by the calcareous * * * which goes unceasingly streaming over them bespeaks the slow march of incrustation in this cavern—and considered in connection with the slight crust which invested the R[oman] reliques, tho exposed to the drop from the period of Antoninus most probably may serve as a species of chronometer to indicate the comparative length of time it took to precipitate the solid and deep crust which seals down the bones beneath. Names chalked on the wall, years back, still resist the encroaching†

- [7] At no period therefore from the sepulture of the animal remains in the loam was this cavern sacred from the intrusion of man through all the grades of savage and civilized life—

To his agency may be ascribed those embarrassing anomalies which we have recorded in the progress of our researches—

It will also be collected from the tenor of the argument, that subsequently to the destruction of the animals which are buried in the cave, there is no evidence of the recurrence of any of the numerous species, if we except the Deers bones and the so-called relics of modern mice [?]

- [9] *Preliminary View of the remains in strata prior to the Diluvian*

Before we come to a particular consideration of the remains appertaining to the surface of the earth we conceived it may

- [6] † In the German caves the progress of incrustation is much more rapid. M. Goldfuss found a large layer of it covering the names of M. M. Esper and Rosenmüller whose visits did not date more than thirty years before his own —The consequence of this rapid accumulation modern bones of Bear which retire thither to die, are arrested by it and superinduced in the same mass over the fossil, from which among other diagnostics, the difference of size will always distinguish them—

be interesting to those who have not access to Works on these subjects to preface it with a rapid sketch of the organic remains contained in the preceding strata—

These have been enumerated by Cuvier—beginning with the oldest formations, make known the animals which they contain and passing from one epoch to another point out those which successively make their appearance in proportion as we {approach} {advance} the present time.

Zoophytes, mollusca and certain crustacea are the first indications of organic life which begin to appear in the Transition formations—We do not by any means observe at so early a period remains of animals which live on land, and respire air in its ordinary state.

The great beds of coal and the trunks of palms and ferns of which they preserve the impressions, altho they afford evidence of the existence of dry land and of a vegetation no longer confined to the waters, do not yet shew bones of quadrupeds—It is only a little above this in the butimonous copper slates that we see the first traces of them; and what is very remarkable the first quadrupeds are reptiles of the family of Lizards very much resembling the large monitors which live at the present day in the Torrid zone. Several individuals of this kind have been found in Thuringia among innumerable fishes of a genus now unknown, but which from its relations to the genera of our days appears to have lived in fresh water—Every body knows that the monitors are also fresh water animals—

A little higher is the limestone called Alpine and resting upon it the shell limestone so rich in entrochites and encrinites which forms the basis of a great part of Germany and Lorraine. In it has been found the skeletons of a very large sea tortoise the shells of which might have been from six to eight feet in length; and those of another oviparous quadruped of the family of Lizards of a large size and with a very sharp muzzle—

Rising still through sandstones which present only vegetable impressions of a large arundinaceæ, bambos, palms and other monocotyledonous plants we come to the Jura limestone so called from its forming the nucleus of that chain of mountains. It is here that the class of reptiles assumes its full development and shows itself under the most varied forms and gigantic sizes—The Ichthyosaurus unites the characters of the oviparous quadrupeds with organs of motion similar to those of the cetacea—The Plesiosaurus was still more monstrous—and if anything could justify those Hydras and other mons- [10]

ters the figures of which are so often presented in the monuments of the middle ages it would incontestably be the Plesiosaurus—half serpent, half lizard—

Another very extraordinary genus of reptiles abounds in the Oolite of England in the Megalosaurus which much exceeded seventy feet in length—it was discovered by P[rofessor] Buckland.†

A little above the limestone slates is found the nearly homogeneous limestones of the Jura ridges. It also contains bones, but always of reptiles, crocodiles and freshwater tortoises—

It is among these innumerable oviparous quadrupeds—in the midst of these crocodiles, tortoises, flying reptiles, huge Megalosauri and monstros Plesiosauri that some small *mammifera* are said to make their appearance for the first time. But still the class of reptiles predominates. *It is only in the strata that have succeeded the coarse limestone, or at most those which may have been of contemporaneous formation with it, but deposited in fresh water Lakes that the class of land mammifera begins to show itself in any quantity.*

This animal Population possesses a very remarkable character in the abundance and variety of certain genera of Pachydermata, which are entirely wanting among the quadrupeds of our days, and whose characters have more or less resemblance to those of the Tapirs, the Rhin. and Camels—The entire discovery of these genera is due to Cuvier. We have nearly forty species of Pachyder. belonging to Genera now entirely extinct, and presenting forms and proportions to which there is nothing that can be compared in the present animal Kingdom excepting two Tapirs and a Daman.

The Ruminantia of such variety and size, Deer and oxen, giraffe scarcely make their appearance in the deposits of which we are speaking, but the Pachyd. were not the sole inhabitants of the countries in which they lived—In the gypsum deposits at least, we find among the Carnivora, Glires, several sorts of birds, Crocod. Tortoise [?].

Among the Carnivora animals allied to the Bat and Fox &c were notice[d]—Skeletons of Glires also—

Hence it cannot be doubted that this race of inhabitants which might be termed the population of the middle age—this first production of mammifera has been entirely destroyed, and in fact where remains of them have been discovered, there are great deposits of marine formation above them, so that the sea has overwhelmed the countries which these races

† [See Trans. Geol. Soc. Lond. vol. i., New Series Pt. 2, 1824. W.P.]

inhabited and has rested on them during a long period of time—

We are authorized to believe, until the contrary be proved, that at the period when these numerous Pachydermata lived, the globe had only presented for their habitation a small number of plains sufficiently for them to multiply there—and that perhaps those plains were insulated regions, separated by pretty large spaces of elevated chains in which we do not find [11] that our animals have left any traces of their existence—In the same strata there have been found by M. Adolphe Brogniart, trunks of Palms and other plants whose genera now only grow in warm climates. Palms, Crocodiles, and Trioncyces are always attendants on the ancient great Pachy.

The sea which had covered the lands and destroyed their animals left large deposits which still form at the present day at no great depth the basis of our great plains—It had then retired anew and left immense surfaces to a new Population whose remains are found in the sand and muddy deposits of all countries known.

In the extinct population which fills our alluvial and superficial strata and which has lived on the deposit alluded to, there are no longer either Palæo. or Anoplothæ. or in fact of any of those singular genera—The Pachy. still predominate and these are of a gigantic size, Elep. Rhin. with innumerable Horse and large Ruminantia—Carnivorous animals of the size of the Lion &c had desolated this new kingdom—In general its character even in the extreme north and on the edges of the present frozen ocean was similar to that which the *Torrid Zone alone now presents*—and yet there are no species in it absolutely the same as any of those which are found alive at the present day.

It is more particularly in the class Edentata that these races of animals belonging to the period before the last assume a size much superior to that of their present congeners and even rise to a magnitude altogether gigantic—of this sort is the Megatherium participating in the character of the Armadilloes, of the sloths of the size of a Rhin.—

The Elep &c incontestibly formed the population of the [12] continents, at the epoch of the great catastrophe which has destroyed their races and which has prepared the soil on which the animals of the present day subsist.

Whatever general resemblance certain of these species bear to those of our days it cannot be disputed that the general mass of this Popul. had a very different character—and that the greater part of the races which composed it have been

utterly destroyed. no bone of ape or monkey among the inhab. of warm climates—nor of man—

This much is certain that we are now at least in the midst of a fourth succession of Land animals—that after the age of reptiles, the age of Palæotheria, the age of Mammoths, and that of Mastodons and Megatheria has come the age in which the Hu. species aided by some domestic animals peaceably governs and fertilizes the earth and that it is only the deposits formed since the commencement of this age in alluvial matters, peat bogs and recent concretions that bones are found in a fossil state which belong all of them to known and still living animals. Such are the Human Skeletons of Guadeloupe imbedded in a species of Travertin formed of land-shells and madrepores of the neighbouring sea—The bones of Oxen, Deer roes and Bears common in Peat bogs and all the bones of men and Domestic animals found in the mud and sand deposited by Rivers in burying grounds, and upon ancient fields of battle—None of these deposits belong either to the peat deposit formed at the time of the last Catastrophe nor to those of preceding ages—Theor. 296—†

[14] *Note on progress of creation towards Land animals*

A gradual advance from the almost {primeval} {simple} corral near the primitive strata thro all the wonderful variety of form and structure visible in Shells, Fishes, oviparous quadrupeds in 2^{dary} limestone, Amphibious animals and Birds to Quadrupeds of the Diluvial land. The oviparous Quad. first occur in secondary limestone or Magnesian—Next Lizards Tortoises in Jura and Lias Limes^a. In Paris formⁿ first appearance of Birds and ferocious Quadrupeds—Next Eleph. Bear—

The Ichthyosaurus, the Plesiosaurus, and several species of crocodile are found beneath the chalk in the deposits commonly called the Jura formations—The monitors of Thuringia are supposed to be still older—The enormous crocodiles and the great tortoises of Maestricht are found in the chalk formation itself—(but these are marine animals—) more abundant larger and more varied in the ancient strata than at the present surface of the globe—

This earliest appearance of fossil bones seems, therefore, already to indicate that dry lands and freshwater had existed before the formation of the chalk deposits—but neither at this period nor even long after have any bones of land-mammifera been encrusted; or at least the small number of

† [Cuvier's "Theory of the Earth." W.P.]

these which are alleged to be found in strata of these dates forms but a trifling exception (Deer ?)—We begin to find bones of marine mammifera, of Lamantins and seals, in the coarse shelly limestone which covers the chalk in the neighbourhood of Paris : but there are still no bones of terrestrial Mammifera. The moment we arrive at deposits which rest upon coarse limestone, *the bones of land-animals present themselves in great abundance—*

As it is reasonable to believe that Shells and Fishes did not exist at the formation of primitive rocks, we are also led to conclude that the oviparous quadrupeds began to exist along with the fishes, and at the commencement of the period during which the secondary rocks were formed ; *but that the land animals did not appear upon the earth, at least in any considerable number, till long after ; and until the coarse limestone strata, which contain the greater number of our genera of shells, altho of species different from ours had been deposited* reposing on freshwater formations. Theory. P. 97.

In beds of alluvium deposited from fresh water occur the Palæotheria, Anaplothæria.

The most celebrated genera which belong to known genera or to genera closely allied to those which are known such as the fossil Elep. Rhin &c do not occur along with those more ancient genera. The former never occur in stony beds—it is in diluvial formations alone that they are discovered

Lastly the bones of species which are apparently the same as those that are still found alive are never discovered except in the last alluvial deposits formed on the sides of rivers or on the bottoms of ancient pools, or marshes now dried up or in the substance of beds of peat or in the fissures and caverns of some rocks, or lastly at small depths below the surface in places where they may have been buried by the falling down of debris, or even by the hand of man—and their superficial position renders these bones, altho the most recent of all, almost always the worst preserved.

Upon a review of the successive phenomena exhibited by the strata of the earth, we are inclined to conclude with Cuvier that there has been at least one, and very probably two successions in the Class of Quadrupeds previous to that which at the present day peoples the surface of the Earth.

Introduction to particular Descriptions of Mammalia [15]

From a survey of the successive strata which form the frame of the earth from the primitive and Transition rocks upwards we find that oviparous Quadrupeds after Zoophytes

shells Corals fossil wood, were the first called into existence—were aquatic or amphibious—coexisted with fishes and were more ancient than viviparous which are a link higher up in the scale of organic life.

After a long interval mammifera appear—they are found in the lowest marine formation of the Paris basin

Others occur in the alluvial deposits and are therefore supposed to be of much more recent origin—these animals were the Palæotheria or Anaplothæria (Etymol. ?)

They were also quadrupeds whose races have totally disappeared and from the fact of their occurring in certain places we may infer that they occupied only insulated regions of the earth bounded probably by ridges and defiles—

The sea which submerged the land they occupied with themselves left large deposits which still constitute at the present day at no great depth the basis of our present plains—It had then retired anew and left immense surfaces to a new population. Theory of E. 280

[16]

Remark

It is in those events that approach nearer to our own times that we may hope to find some traces of more ancient events and of their causes—(Theor. 241)†

These are the codices rescripti in the archives of the earth out of which the antiquary will one day decipher the almost obliterated traces of her former condition as well as the history of her former changes. Jamiesons illus. of Theory. 427—

We observe the organic world by a regular succession of organic formations—with youthful vigor restoring its population—reuniting them by fresh and more perfect combinations—until we arrive at the most creation of wisdom and power in man who was henceforth to exercise dominion over the material universe—

[17]

Inferences from a review of Quadrupeds.

Over this new region the Pachydermata still predominated—animals of a gigantic stature, Elep., Rhin., Horse and several large ruminantia—Carnivorous animals of the size of the Lion, Tiger, and Hy. had desolated this new kingdom. In general its characters even in the extreme north and on the borders of the present frozen sea were similar to that which the Torrid zone alone now presents—and yet there

† [See Kerr's Cuvier's "Theory of Earth," § 34, p. 174. W.P.]

was no species in it absolutely the same—as any of those which are found alive at the present day.

Elephant

[19]

The most remarkable of these lost animals is the species of the Elephant named Mammoth * * * * by the Russians, and *Elephas Primigenius* of Blumenbach, which was fifteen or eighteen feet high and was covered with a coarse red wool along its back—as Individuals of it with their flesh skin and hair preserved in icebergs from the last general catastrophe testify. Thousands of its carcasses from Spain to the shores of Siberia, throughout North America shew that it had been distributed on both sides the Atlantic if indeed that ocean had existed in its time in its present bed. Its enormous tusks were planted in alveolæ longer than those of the Eleph^t. of the present day, but in other respects resembled the Indian Elephant. Its tusks are so well preserved in cold countries as to be applied to the same purposes as fresh ivory—

The tartars and Chinese imagine it to be animal which lives under ground like the mole and perishes at the sight of day.

And in Europe bones of Elep were considered to be the remains of Giants (St. Austin) Hernandez has a written a treatise expressly on the enormous magnitude of the Human race as inferred from the size of the bones which he took to be human, but which from their {figures} {description} now prove to be the remains of Elep^t.

Habitat of Elep

[20]

The modern Eleph peculiar to the old world—In America there is no living animal that can be compared to it either for figure or magnitude They are natives of the warmest Regions and tho they are capable of existing they cannot multiply in temperate climates—

The species distinguished as the Indian Elep, inhabits all that tract of India boths this side the Ganges—thence or Ceylon all the individuals brought from[? to] Europe come—there is no reason to doubt that it is the same species which inhabits ulterior India and which peoples the forests of Siam of the Burman empire and Cochin China.

The number of the hoofs is five before and four behind. There is no authentic proof of its existence in Africa—tho neither is the contrary proved—

The species which is known as African inhabits the Cape, Senegal and Guinea—from which came the celebrated skele-

ton constructed under Louis XIV and from the Cape—It is also probable, it is the same which occupies the intermediate country of Africa.

Since 1681 no African Elep has been seen in Europe, until the young female fig by M Cuvier, which is now alive in Paris, presented by the Pacha of Egypt—Its habits as far as those of a young one can be relied on, exhibit none of the ferocity usually ascribed to it, and are indeed fully as mild, intelligent and tractable as those of the Elep of Asia. The number of the hoofs is four before and three behind.

[21] *Modern Elephant—Characteristic Differences*

There are two existing species of Elephant possessing distinct characters differing as much from each other as the Dog does from the Hy or the Lagomys from the Hare—

The surfaces of the molar teeth of the Indian Eleph^t exhibit fasciæ of enamel irregularly festooned—while in those of the African Eleph^t the enamel assumes a lozenge shaped configuration

In addition to this difference of their dentary system, the head of the African is smaller, more elongated and less irregular when compared with the Asiatic.

The rounded forehead of the African strongly contrasts with the deep depression in the middle of the latter—the ear of the former is twice the extent—while the tail is only half the length—

- [22] In its structure it resembles the Rongeur, in the form of the head and teeth particularly It is strange that there should be between extremes such approximation—between the Elep and Mole!—

[25]†

Fossil Elephant.

Mr Parkinson deduces the existence of two fossil species,† agreeing one with the Asiatic [? African], the other with the In. but only one fossil species is supposed to exist, and even this differs from the living Elep of Africa and India, nearly as much as they differ respectively from each other—more than the Horse does from the Ass—It bears the strongest affinity to the Indian—but while in the structure of its teeth the fossil animal approximates to the Indian, in the form of its head as inferred from the peculiarities of its physiog of its face and trunk Cuvier thinks that it resembled in form

† [Pages 23 and 24 are blank. W. P.]

‡ [“Organic Remains of a Former World.” By James Parkinson, in three volumes, 1811, vol. iii. p. 349. W. P.]

the Ceylon Elep—constituting a middle term between the Indian and African—but remoter from either than the ass from the horse and the Jackal and Isatis from the Wolf and Fox.

Its tusks were generally large frequently more or less spirally arcuate and directed outwards. The size, judging from some enormous fossil teeth, must have considerably exceeded the existing species.

No person has seen in a modern state bones resembling these by which this species is peculiarly distinguished—nor have the bones of the 2 modern species been found in a fossil state.

Fossil Habitat of Elep

[26]

The remains of the Elep are diffused over the surface of England mixed up with the accumulations of gravel at the base of hills around London as at Woolwich, Highgate, Brentford and in many other localities—They are traced in Kent Suffolk, Northamptonshire, Essex, Wilts, Dorset, Somerset, Flint and Gloucestershire—

They have been met with, tho rarely, owing perhaps to want of observation, in Ireland and in Scotland.

Norway and Sweden have likewise produced them and even Iceland is not without them—

But they abound in nearly all the European continent—over Russia, Poland, Germany, Hungary, Holland, France, Switzerland, Spain, Italy—In Siberia there is scarcely a spot from the Don to Kamtschatka where they are not abundant.

Lieut. Kotzebue has described them in icebergs near Behrings Straits—on the north western angle of the continent close to Behrings straits.† B. Humboldt in the Himalayah mountains and recently they have been seen on the bank of Irawaddy in Asia—(mastodon) not Elep.

In South and North America they have been lighted on—They are stated to have been found in one or two instances only in the German caves—Eight or ten only have been found in Kirkdale—

Number of his teeth and remains

[31]‡

No perfect bones of the Elephant have yet appeared in the cavern—one large Epiphysis has been found, and that so

† ["A Voyage of Discovery into the South Sea and Bearings Straits, undertaken in the years 1815–1818, in the Ship Rurik under the command of Lieutenant Ollo Von Kotzebue, in three volumes, (London, 1821,) vol. iii. pp. 298–9. W. P.]

‡ [Pages 27–8 are blank, 29–30 are missing. W. P.]

gnawed at the edges, that it exhibits transverse furrows through its circumference—like the furrows made by a file about a dozen longitudinal splinters or stakes are the whole amount of his remains with the exception of the portion of the head of the young Elephant from the Idol Cave and the numerous teeth the head retained one of its tusks, and both its teeth—the teeth are quite perfect as during the animals lifetime—but the tusk and its sheath of bone were crushed under a mass and broken across in the middle—However I succeeded in reuniting its parts—it measured better than a foot, thus corresponding to the size of the teeth which were only its second set? and yet unused—The tusk retained only its phosphate of lime and adhered to the tongue—The bones of the head fell to pieces beyond the power of restoring them—and here I may remark that the bones of herbivorous animals were observed to be more fragile and worse preserved than those of the carnivora, which were generally compact and solid—

There was another tusk discovered in the sloping chamber—it preserved all its whiteness, but its component laminae exfoliated plate after plate—it was injured in extracting it that its dimensions cannot be given with any certainty—it may have been dropped out of the head just mentioned in its carriage to the Idol cave—

[33]

Number of Elep Teeth

I am in possession of thirty-six perfect teeth—exclusive of single plates and fragments of teeth of the Elephant—The number dispersed in collections and among indiv^{ls} I have ascertained to be twenty-four—making in all sixty—

The majority of them belong to young and infant Elephants—about half a doz to adults—and 4 to very aged Individuals.

by reference to Plate fig—† a milk tooth is fig. which had not been quite formed—between the plates of the enamel there exist void spaces as yet unoccupied by the osseous matter—these may be seen filled up in fig * * * † only two of these unformed teeth have been found.

Figures one two and three§ represent the gradual progress of growth and wear in the milk set—of this description about 6 specimens have been found.

From this diminutive size there is a progressive advance thro all the intermediate stages to that of adult and aged

† [Fig. 1, Plate M, "Cavern Researches." W.P.]

‡ [Fig 2. Plate M. W.P.] § [Plate M. W.P.]

animals—of the teeth of adults only 8 have been found—having the complement of its plates varying from 13 to 15—only 9 or ten of the plates brought into action—and of those of ancient Individuals only three—The number of plates varying from 14 to 16—the entire surface is worn down to an equal surface—measures eight inches—

The remainder of the collection consists of intermediate sizes between the milk and the adult teeth—averaging four inches in length and 2 in diameter—comprized in ten or 12 plates and weighing * * * * The plates of one specimen are nearly double those of others—

In some of the specimens the grinding surface is not in the least rubbed—in others it is partially—and in a third kind it is reduced to a smooth and level surface and ground down nearly to its base or fangs—

In two specimens of this last kind, remnants of the former [35] or anterior tooth, dwindled to nothing is still seen clinging to its successor which is fast advancing to supplant it—and is itself already threatened with a similar fate—

The absorbed and rejected teeth which may not have yet been quite pushed out are likewise found—one specimen merits particular notice—from its altered character that it is scarcely recognizable as the tooth of the Elep—it is a solid wedge shaped mass with an elongated fang or rather collection of fangs compressed into one—It weighs double the proportion of the other teeth

The degree of preservation of these several teeth is incredible—in {appearance} {aspect} they are in no respect distinguishable from those of {living} {modern} animals—

Old teeth alone have suffered by their long residence in the earth—the osseous zone which binds the plates together has been corroded exposing the insular enamelled plates in relief—this character is beautifully displayed in Mr Belfields tooth—and {one} {another} in my possession—

None of the teeth present the least vestige of gnawing—being composed of solid ribs of enamel, the teeth of ossiferous animals glanced off from them without leaving an impression—The softer sheath of bone of the head was devoured and these rocky morsels defied the crashing power of the Hyænas jaws—

Rhinoceros—Modern—

is not known in America nor does any Americ[an] animal bear the smallest resemblance to him—less generally diffused

[39]†

† [Pages 37-8 are missing. W.P.]

than the Elep—is confined to the deserts of Africa—to the forests of the southern regions of Asia.

Fossil—

In this country it is met with in caves and in superficial gravel—occurs in France, Italy, Germany—

[40] Number of Species—

1 That with the partitioned nose—R. Tichorinus—(Toikos paries. Rin nasus)

2. That of Italy with *unpartitioned* nose—*slighter* and pointed nose—Rh. Ptorhinus—(from Leptos tenuis)—

3 That of Germany of the common size—furnished with *Incisors* Rh Incisious—

4 That found at Moissac—R. minutus—about the size of a Hog—

28 teeth—7 in each jaw—

[41] *Difference of Species of fossil Rhin*

The Kentshole Rhin resembled the most common species in Germany and England and which is found with the Elep to the shores of the frozen sea where like the latter it has left entire {carcases} {individu^a} encased in ice—it was two-horned—and wanted Incisors—in this particular it differed from the present unicorn Rhin of the East Indies which possesses them—and approximated to the Rhin of the Cape which is without them—it differs both from the species of Asia with one horn and that of Africa with two. yet it was not absolutely like the African species and in the structure of its teeth it had characters in common with that of Java There is a considerable interval between the horns in the fossil—in the African species their bases touch—implying a greater length of skull—

An essential difference therefore arises from the presence or the absence of the incisors—after much research Cuvier affirms the common fossil Rhin wanted them like the Bicornie of the Cape.

Does this feature mark a difference of species—most probably—if one bears in mind that there occur in the same country Germany a species armed with Incisors—it is true that instances of the latter are extremely rare—and the incisor teeth that are alleged to be fossil are of a diminutive size compared with the unicorn of Sumatra which boasts of large ones—and in both jaws.

Cuvier considers that the fossil head was larger than the

modern and larger in proportion to the height of the limbs—From the specimen preserved in ice we learn had not those protuberances which render the unicorn of India so hideous—but that it was smooth like the bicorn of the Cape—The feet were thickly clothed with hair which is not the case with the Rh of India or the Cape—whence Pallas infers that this animal inhabited a colder climate than that of our days and the long hair and wool of the fossil Elep gives some countenance to this conjecture—

These two important facts conspire to show that at the [42] epoch preceding the last revolution of our globe, the cold countries which border the Pole had also their great quadrupeds of the Order of Rhin and Elep—as they have at the present day their order of Ruminants the Musk Ox, the Bison, Elk, Canad. Stag and Reindeer—in the order of Carnivora their White Bear &c—

Inference

[43]

This large species of quadruped, says Cuvier, unknown in our days is found therefore buried in this cavern, as well as in Europe and Asia and what is more remarkable no more than the Elephant it has not been transported from a distance—nor was it by slow and insensible changes but by some sudden revolution it has ceased to exist—

The ice on the banks of the Wilhovi in 1770 demonstrates these two propositions—How could it have been drifted from the Indies or any other warm climate without being dismembered in its march, or decomposed by the heat—How could it have been preserved if the ice had not instantly enveloped it and arrested decay—and how could it have frozen and preserved it if the change of temperature was slow and imperceptible—

Remains of Rhin in Cavern

[45]

The Rhin scarcely yields to any other animal in the enormous quantity of its remains in the cavern—Innumerable teeth and detached portions of skeletons occur at every step exhibiting all the various shades of age from the half formed cub to the aged and worn out—

Of half formed specimens or mere shells of teeth Plate 1

Fig. * * * † . . . there are 2

Of milk unworn teeth Plate 1 Fig—2 . . . 30

† [Teeth of Rhinoceros from Kent's Hole are figured in Plates L and M, "Cavern Researches." On the first of these, there are ten figures all of which, with the exception of the sixth only, are teeth. Plate M contains figures of two "teeth of young Rhinoceros." W.P.]

Of milk teeth of which fig 5 is a type	.	.	.	70
And of * * * of which fig 3 is a representation	.	.	.	12
Very old and worn fig 4	.	.	.	30
Second set unused—fig 9	.	.	.	30
Teeth of adults yet untouched fig 10	.	.	.	60
Teeth classed under fig 8	.	.	.	70
Still larger and worn fig 7	.	.	.	100

Over 1800 †

Besides these portions of jaws—no Incisors—no Horns, [they] consist of a compact bundle of hair which would of course moulder in the ground.

The teeth enumerated belong to the upper jaw—There is about an equal proportion of the under jaw, of which fig 1—and 2† are delineations—

To this number under my eye while writing in my collection a hundred at least may be added, dug out by different individuals—

[47]

Bones

And there is a corresponding {accumulation} {number} of Bones—of the Head—some detached parts—

Three bony bases of the Horns of the Rhin—Fig 6. Plate 2^d §

2 atlas, vertebræ—
 Numerous scapulæ
 Of broken femora—50 in my possession
 Tibia—shin bones
 Humeri
 Ulnæ
 Radii
 Acetab.
 Os innom. . . . 40
 Astragali
 Footbones
 Patellæ

The bones of young animals corresponding to the milk accompany the teeth—I possess the humerus of a Rhin. which measures only 8 inches—it wants its epiphysis—it escaped without gnawing—

The number of the Individuals which supplied these remains, allowing to each their full complement of 28 teeth may be computed at from forty to fifty.

† [There is some error in these numbers. W.P.]

‡ [Plate L. W.P.]

§ [Fig. 6, Plate L, "Cavern Researches," is that of the "bony Base of the Nose Horn of Rhinoceros Gnawed round its edge" W.P.]

Femora, Humeri, broken

[48]

The teeth generally escaped unharmed—there are not wanting however examples whose fangs are eaten away, and sides rent and gashed by piercing gravers of teeth—It is in the large bones especially that we see the astonishing effects of the ossivorous machinery of the Hyæna—The extremities of the femora have been snapped off and consumed; those parts being softest and most nutritive—and the process has been performed in so uniform a manner that in the fifty specimens before me there is no variation discoverable in the mode of {operation} {breaking}—Pl. Q,† most perfect—Pla P.—Fig 5† average state of the entire number—Those belonging to young individuals suffered most and were reduced to nearly shapeless stumps—Fig 4†

The same remark as {regards} {exhibiting} the Hyænas mode of breaking them applies to the Humeri. Pl Q Fig 1† shews the least injured—but the condyle is destroyed in the generality. Fig 2† conveys a correct idea of the condition of all these bones—Those which preserve their condyles are deeply lacerated and indented—Plate Q. Fig 1—† but in the majority the extremities were demolished—and as far as the muzzle of the animal could search into the medullary regions the cavities were ransacked for marrow and its cellular seat torn away in the animals eagerness—In the case of bones shivered against the rocks the spongy structure of the interior is as well preserved as the external shafts—many of these limbs have been crushed through the middle and split longitudinally—These have been thoroughly despoiled of their cellular lining—and are even polished smooth internally by repeated licking—they are divided in few instances—and the {broad surfaces} {transverse furrows} universally attest the repeated attempts and failures to crack the impracticable mass—The animal in this extremity resorted to chipping off morsel after morsel from the truncated ends, and finally smoothing and fining off the rugged points—Pl. R. Fig 6†

The cubitus of the Rhin have been chopped at their [50] smaller end Plate Q—Fig 3†—as indeed is the case with the generality of the bones and the seat of the marrow thus by degrees approached—They are less mutilated than the other large bones probably because they {contain a smaller proportion of nutriment} {are more solid}—but not a single specimen however has eluded the H. search[ing] eye, nor escaped the ordeal of his jaws. deep groves or bands of gnawing

† ["Cavern Researches." W.P.]

‡ ["Cavern Researches." Pl. P. W.P.]

indent the bony cylinders—The same may be said of the Radii which are commonly broken about half way at their slenderest points—Pl. Q—F. 4†

About a dozen of the acetabula are tolerably perfect allowing for profound gutters, the consequence of gnawing round the edges of the cup and along the ossa innominata—The least injured is given Pl. P—F. 3†—but the majority have been broken up—and the ossa innominata found separately as has been already pointed out in the enumeration of the bones—and these insulated parts have shared the fate of the rest and together with the Patellæ, astragali ossa calcis, phalanges, and are channelled with the furrows of teeth—resembling rough lines produced by a file—Pl. P—Fig 6—†

[52]

Reflection

In fact the Hy. appears to have had a rich and constant repast on the remains of the Rhin—

From the presence of every the minutest bone of that animal, tho in a mangled state, it is clear that the Hy. found the entire carcasses strewed over the plains; and in the same manner as the white Bear carried away by piecemeal the limbs of the frozen Elep, this animal seems to have dilacerated the Rhin—and borne the detached pieces into his den. The number exceeds the deposit in any particular depot, whether in gravel or caves—

Few or no bones of the Rhin occurred in the German caves
50 teeth was the whole amount of Kirkdale.

At the review of the enormous accumulation of his remains it is impossible to restrain ones astonishment—yet not all his bones have yet seen the light—no doubts thousands of them still lurk in the secret and inaccessible grottos or been carried down with the mud into the bottomless regions of the basins.

How immense therefore must have been the population which covered the surrounding district, now the seat of quiet hamlets and the unmolested range of the Ox and the Sheep—when independently of what mouldered on the plains, such a vast aggregation of one single species was crowded into this retreat nor is our wonder diminished when we consider at this day his remains are confined to the deserts of Africa and the forests of the southern regions of Asia, not known in America or Europe—and only two have been seen in Europe—one of which was presented by the Pacha of Egypt to the king of France and the other in the 17th Cen.

† [“Cavern Researches.” W.P.]

Horse

[54]

Of the horse the numbers are still greater owing in some measure to the greater number of his teeth 40—8 Portions of jaws, with the 2 lips or forepart of the mouths containing the incisors—one of the latter is in a superior state of preservation, and in addition to its full row of incisors contains four canines—Tho the condition of its teeth indicates its having attained its full growth, it is not larger than that of an ass—and may have belonged to a small species of the Horse Genus—a hoof and footbones have been found and are fig† which agree in proportion to the size of the mouth.

The other specimen wants all its teeth except 2 canines—and is in very indifferent condition—both have been gnawed at their bony extremity—as likewise have been the jaws from which all the bone has been torn away, except merely what formed the bed of the teeth and even this is gnawed lacerated and hacked—Vid—Pl. K—fig 5-6†—But of the innumerable teeth which are found separately the alveolæ have been totally devoured—very rarely is even a particle of the head to be met with attached—Three thousand single teeth including sixty incisors and canines have been found—wherever an excavation is opened (always excepting the Bears den) a horses tooth is sure the first to make its appearance and as invariably is [? it] announces the presence of the other Great Herbivora and likewise of the Carnivora—among this heap there is a great variety of size, not merely arising from age, but also of species, but the teeth of the Equine Genus are all so like that it [is] impossible to {infer} {discriminate} differences of species {from a view of the teeth} {by a mere exhibition of these organs} alone—but teeth of the young, adult and old may be distinguished—The chief particular and what strikes every eye is their magnitude of the generality, many of them exceeding by a half the largest Kentish dray horse—

Foreign Localities

[55]

The horse has been found at Cronstadt [? Cannstadt] in Wittemberg with the Elep and R—found in the osseous breccia of Dalmatia, and in all the superficial beds—It is the constant companion of the great Herbiv, claiming an equal antiquity with them—

† ["Cavern Researches," Plate Q, Figs. 9, 10, 11, 12. W.P.]

‡ [In "Cavern Researches," Figs 5 and 6, Plate K, are stated to be those jaws of Ox and Horse respectively. W.P.]

In Arragon bones of the ass occur under similar circumstances according to Bowles and Cuvier—

From the general resemblance in all the species of the Horse Genus it is impossible to distinguish from a survey of an isolated fragment the Horse from the Ass—two or three only found in Kirkdale—

The Horse is not mentioned by the older His[torians] partly from ignorance of its species being mistaken by one for teeth of a Giant and by another of Rhin.—and partly from undervaluing its teeth from their identity with the living animal but since attention has been directed to a closer scrutiny of all the remains it has been invariably found the companion of the lost species—and though from the absence of sufficiently perfect specimens, and the similarity existing between all the varieties of the Horse no characteristic differences between these different species, or from the existing can yet be discerned, but when the science of comparative anatomy shall have been exercised on more numerous and perfect specimens Cuvier prophesies that like the extinct species it accompanies, the horse will be found also to have its distinguishing features from the modern—Cuvier from a survey of teeth in his possession observed upon their inferiority in size to the full grown animal of our days—and Kents Cavern has produced teeth resembling the middle sized domestic Horse—and even the smallest species of the ass—but there are likewise teeth which exceed by a third the largest modern teeth I have been able to inspect—That distinguished anatomist judged from a view of a few isolated teeth—but I am enabled to speak with more certainty from a display of some thousands—as no material difference except in size exists been the Ass, the Mule, Zebra and Couagga, there may be included in those classed as Horses the remains of these analogous different animals of a former era—

- [56] Its remains too have passed thro the Hyænas jaws—and {are} {been} treated somewhat in the same manner as those of the Rhin—but his cylindrical and slender Tibia are particularly remarkable, having been dashed thro near the lower condyle and the bone laid open—It is singular that this is the M[odern] Hyænas peculiar manner of breaking similar bones of the Horse and Ox as was proved by Dr Bucklands experiments on a Hyæna in Mr. Wombwells collection at Oxford† and as I have verified myself at Exeter Change. The lower condyle was protected by its hardness from violence. A dozen tibia of the Horse have been collected all

† [See "Reliq. Dil," Plate 23, Fig. 1, with explanation p. 276. 1828. W.P.]

similarly broken as that fig 1 Pl—R† and of many more we find only the condyle remaining

The several small hard bones of the skeleton such as astragalus, os calcis and the hoofs very little damaged by teeth tho {it is visible} {there is sufficient to shew} that they glanced off from the hard substances—vid Pl. Q. Fig 9, 10, 11, 12.†

The same may be said of the solid bones of the ox. Vid Pl—[Q] 6, 7, 8.†

Ox

Of large ruminants the teeth of the ox are scarcest—no more than forty have been noticed The posterior molars of the under jaw measure four inches in length including the fangs and better than two across—Vid P. Fig—† and the other teeth are in proportion—They {are} {surpass} the size of the teeth of the largest ox that I have had an opportunity of examining—and must have belouged to a gigantic species—

There is also a less size—their worn surfaces show that they were not mere varieties of age—

The teeth of calves have been likewise found—

The alveolæ have been completely destroyed—only in one instance a part of the gum was found attached to the tooth—

No horns of the ox have made their appearance—Their too porous and spongy nature rendered them liable to decompose [60]§
—Vid Radius (perfect of Ox)—|| [57]

Heads of a Buffalo of enormous size are found in Siberia [67]¶ and prove to be different from the great Buffalo of India—like the horse it is found mingled with the bones of Elep and Rh and of course contemporaneous with them—

In a specimen found in Dumfries shire, now in Mr. Parkinsons collection the length of the bony core is two feet six in. the circumference at the base 17 in. the distance between the horns two feet eleven in. and the breadth of the forehead above a foot—In others found near Rome the dimensions are still greater—

Fossil Ox Bovine

[68]

Heads resembled those of the Aurochs or Buffalo or bison of America. The heads which resemble the domestic ox are

† ["Cavern Researches." W.P.]

† [Fig. 5, Plate K, "Cavern Researches" is that of "Jaw of Ox." W.P.]

§ [Pages 58–9 are blank. W.P.]

¶ [Not figured in "Cavern Researches." W.P.]

¶ [Pages 62 to 66 are occupied with Deer, &c. W.P.]

found only in turbaries or other superficial beds—the original of the domestic ox—

The total number may be estimated at fifty—many of the teeth belonging both to the upper and lower jaws are of extraordinary magnitude—and must have belonged to a species of ox double the size of the domestic animal.

The bones of the ox are not numerous and observe a due proportion to the small quantity of the teeth—2 large humeri fig.—† have been found entire in extraordinary preservation—agreeing in size and character with the same bone from Breugues which belonged to the fossil Aurochs—the rest are broken like those of the horse and deer—in the manner of those fig— Pl. R—†

[62]

Deer

There are numerous reliques of the {Genus} {various species} of Deer, of species at least equalling in size the Irish Elk there have been found entire palate fig.§ and a dozen single jaws and as many more fragments—exhibiting the different stages of dentition of which many preserve unworn their pyramidal surfaces—and a few are abraded to the roots and gum—and about a hundred single teeth belonging to the upper and under jaws, including incisors—

The under antler looks downwards as if it fell over the eye.

Three beams of horns agreeing in magnitude, in their arcuate form and the {position} {direction} of the brow antlers to the Cervus Megaceros or Irish Elk—They give off only one antler at the base of the shaft. They were broken off below the sur antler—the longest measures a foot and 4 in. they were cast horns. Several large bones of corresponding magnitude and innumerable splinters belonging to Deer were gathered—

The specifick characters of the head and horns demonstrate that the stag with gigantic antlers is an extinct animal like the Rhin with prolonged head, the Elep with long alveolæ, the gigantic Tapir.

There were also found a few jaws, a considerable quantity of single teeth and the bas[e] of horns of a species allied to the great red Deer—they vary in circumference measured by the bead like circle of the base from eight to 13½ inches—

† [Not in any Plate known to me. W.P.]

† [“Cavern Researches.” W.P.]

§ [Fig. 1, Plate I, “Cavern Researches,” is that of “Palate of a large Elk.” W.P.]

Fig. P * † and above the brow antler 11 in.—the beam diminishes above the 2^d. ant[ler] at an interval of two inches, gives off two antlers—shaft compressed—and it is worthy of remark that the six most perfect horns are broken a few inches above the second or sur antler at the slenderest and most practicable point of the horn—and they measure precisely the same length—eight inches—

The rest of the horns were uniformly broken off a few inches above the coronary circle between the two antlers.

There are about a doz belonging to Stag of inferior size, [63] but in form and condition like those of the red Deer—measuring by their coronary zone from 6 to 7 inches—which send off the brow antler about an inch above the root—There is also a description of horn of equal dimensions, which gives off its brow antler immediately from the base and thus agreeing with the common fallow deer—

There is a still smaller sized horn from five to 6 in. in circumference which gives off two antlers, the lowest from the root of the horn—the other at an interval of four inches—In this respect it differs from the fallow Deer, whole antlers are from 7 to 9 in. separate. It has not the bend of the horn of the fallow Deer, but is straight

The {immature horns} {germs} of small deer have been met with—

The majority were cast horns—exhibiting the smooth convex surface characteristic of horns shed annually by necrosis—but there are two specimens particularly belonging to great red Deer—which still retain their frontal bones and discover marks of violent separation from the head—Fragments of the processes of the antlers chewed to nothing attracted our observation—

Rein Deer.

[64]

From an accurate comparison of several of the small horns and bones I am inclined to believe that they possess a specific identity with those belonging to the Rein Deer found at Etampes and in the Cave of Breugues. The character which Cuvier assigns to the rein deer are discernible in them—They are round at their bases—throw off the brow antler about an inch above the root—and at the distance of two inches give a superior one tending in a different direction from the inferior and rather backwards which is also the tendency of the shaft of the horn, which tapers above this—The inter-

† [Fig. 3, Plate H, "Cavern Researches," is that of the "Horn of Red Deer." W.F.]

mediate space between the two antlers is dilated and assumes a flattened form in other specimens exhibiting in nearly contact the germs of two antlers above the brow—

The only remarkable difference is that the shaft of the horn is not {bent} {reflected} backward as strongly as in those fig. by him Plate 6—106. 4 vol. but whether this was not the case in the upper branches of the horn we cannot decide the longest fragment not exceeding seven inches.

I have also identified the canon of a deer with that fig. in the same plate by Cuvier fig. 8—It has the deep channel along its shaft which discriminates this bone in the Rein deer from the other species.

In the measurement of the horns and bones they precisely accord—

If then as is most probable the Rein Deer occurs with Rhin and Elep and other Cave [animals, in] it we behold an inhabitant of the frozen regions of the north accompanying the remains of animals which at the present day occupy only warm climates—and Cuvier says it goes to show that the other animals inhabited a cold country—

[65] If the fossil Reindeer was of the same species as that now existing, or of a species with the same habits, its coexistence with the Rhin in the caves of Kents hole and in Brengues, and at Etampes will prove that the species of the great Quadrupeds whose bones are in diluvium dwelt in cold or temperate climates and existed in the very places where the bones are found interred, without supposing that these countries had undergone any {great} {material} change of temperature—

The presence of the glutton confined exclusively to the frigid zone countenances this view which receives additional support from the absence of the quadrumana neither a monkey nor a mahi has ever been observed—supposing the temperature of this climate to be that of the torrid zone we should look for the population of the torrid zone—

[66]

Condition of the horns

The pointed brow antlers of the large horns are all eaten away to the trunk—and the arborescent lines of the arteries on the surfaces of the shafts are traversed by transverse impressions of teeth as is represented in fig * *† but this effect is still more strikingly marked in the horns of the small

† [The horns figured in Plate H, "Cavern Researches" are said to have been "gnawed to their actual state by Hyænas." W. P.]

deer† which exhibit irregular rings of furrows effected by the meeting of the teeth of the Hy.—resembling rudely carved circles—The broken extremities of the horns have been scooped in search of marrow.

The total number of horns which with {one or two} {a few} exceptions I possess may be computed at sixty—and nearly as many more had crumbled to dust like slacked lime when disturbed and others in the ground—it required the greatest care to extract even the firmest—Their absorption of moisture reduced them to the state of pulp—but on exposure to the air they hardened to such a degree that they split—

Bear

[69]

It is impossible to compute with any certainty the number of the teeth of the Bear in the range of the Bears den—every stroke of the pick disclosed single teeth or bones—and we have already adverted to the multitude of its remains under the cracked floor in the centre of the Bears den—There still remain thousands of its teeth buried in the indurated floor in all the avenues to that extraordinary retreat—

Besides the number of teeth which have been extracted entire, hundreds have been destroyed in the operation—I must therefore leave the reader to form some estimate himself when I state that the under surface of an area of * * * was literally paved with the remains of this animal exclusively in all the gradations of growth, wear and preservation—

Few or no remains of this animal has been observed at Kirkdale—on the other hand the bear predominates on the Continent—This cavern unites both extremes—in this isolated range the Bear abounds in excess as in Germany—in the other branches it is found mingled {tho scantily} {in small numbers as compared with the other remains} as in Kirkdale—

It has been already remarked that these remains suffered nothing from animal violence but were simply crushed by the subsidence of the floor—

But when we survey the great deposit of the congregated [70] remains of the various species in the other branches of the cavern, the transition is we meet with no longer closely packed layers of its bones but a straggling tooth or bone—but though as we shall presently see it does not abound in equal numbers as in that insulated range, we find however scattered thro the other parts of the cave along with the bones of the Herbivorous and carnivorous animals a still greater variety of its species—Tusks and single teeth to the

† [Fig 1, Plate H, "Cavern Researches." W. P.]

number of 150—and half a dozen entire under jaws with also some fragments have been dug out of the same beds with the animals already recorded—no inconsiderable quantity of their bones also has been discovered—and it is singular that they have escaped almost entire from the fate which has befallen all {the others} {their companions}—Pl N.† but sufficient however have been found to indicate that some ossivorous animal has been at work at them two or three of the jaws are broken abruptly off at their condyles in the manner we shall hereafter specify in speaking of the condition of the remains of the Hyæna—The tusks which with the single teeth remained after the destruction of the jaws are gnawed at the base of their fangs and present the curious marks of the collision of the opposite canines of the Hyænas jaws as may be seen in fig 7 Plate—R—†

- [72] The remains of this animal have been found in all the different stages of growth and wear—I possess the jaw of a very young Bear with its second set of teeth yet concealed in the gum—and numerous single teeth that have not yet shot their fangs, with all their enamelled eminences in high relief—as fig. P.‡

There are on the other hand Tusks which have been worn down below the enamel to the bony fangs—and molars abraded to a smooth surface—The majority of the grinding teeth however while the tusks are broken apparently from breaking hard subs[tances] as bones are very little worn, which would intimate that the Bears of those days were less exclusively frugivorous than the modern species, and lived partly on flesh—

Here I cannot help noticing a circumstance relating to the teeth of the Bear which has already been mentioned in reference to those of Elep viz that the teeth belonging evidently to the same individual were found detached in different parts of the cave two tusks particularly remarkable for the curious staining of their surface alternate streaks of yellow and brown were found in different parts of the cavern—

[74]

Species of Bear

The remains of the Bear in the Bears range approaches nearest to two known fos[sil] species of the gigantic stature Bear which is diffused in the caves of Germany over an extent of two hundred leagues—remarkable for the abrupt

† [“Cavern Researches.” W. P.]

‡ [Probably Fig. 7, Plate M, “Cavern Researches.” W. P.]

elevation of its forehead—which M. M. Blumenbach and Rosenmüller have designated as the *Ursus Spelæus*—and to an inferior size which is distinguished by the appellation of the *Ursus Priscus*—but they tenants of this Den appear to possess specific differences—

The latter is remarkable for possessing in addition to the small anterior molar seated at the base of the canine (speak first of the jaws actually like the *U[rsus] P[riscus]* then of the sub-species) another similar tooth at a short interval preceding the row of grinders—a peculiarity in the fossil Bear which has not yet been noticed—hence it differs from those previously known even in the great theatre of the Bears habitation in Germany—and likewise from the living species.

From a comparison with the living species M. Cuvier is of opinion that while in its profile it resembles the Brown Bear of the Alps, in other particulars it approximates to the black Bear of America—and the circumstance of its partaking of the characters of one and the other to a certain point renders it necessary to assign to it a distinct classification—Only one specimen of this description? and that under rather doubtful circumstances as to its high antiquity was found at Gaylenreuth and was the property of M de Sœmmering—this peculiarity is strongly defined in the specimen belonging to Mr Welland and in half a dozen more jaws in my possession—

The jaws are about one third larger than in the head of a large Alpine Bear in my collection.

Nor is the *Ursus Priscus* the young of the following species, for I possess numerous tusks and also some jaws which are worn down and discolored by age—

The largest of the teeth of modern Bears are inferior or at [75] most only equal to the smallest of the fossil—and are generally one fourth less than the largest of the cavern teeth which judging from the proportions of the heads and bones equalled the horse in size This invariable superiority announces a difference of species which the examination of other parts justifies.

Gigantic Bear of this cavern is distinguished by the presence of an anterior molar at the base of the canine as marked 'a' fig.—Plate * * * †

This tooth has been found in very young animals of an inferior species, and the half obliterated traces of it have

† [The author here refers to fig. 1, Plate D, "Cavern Researches." The "a" does not occur in the published Plate, but a copy of it containing the "a" inserted in pencil by Mr. Mac Enery, has recently (June 1869) been presented to the Torquay Natural History Society, by Mr. Gardner, Torquay. W.P.]

been observed by Cuvier in one or two fossil specimens, while it was altogether effaced or was always wanting in twenty other specimens examined by this illustrious naturalist—but in the specimen under consideration it is standing—and from its worn state and belonging to a very old individual it would appear to have been assisted in mastication which is not the case with these false teeth or rudiments of teeth.

Hence it appears that there are two species of Bear if not specifically different, allied at least to the fossil species in the German Caves.

There is a third species remarkable for the extraordinary magnitude of its coronoidal process of the jaw measuring in a perpendicular line from the top to the base or edge of the bone 7 in.—and from the posterior molar across to the articulating process 6 inches—Notwithstanding these large dimensions the teeth are not larger than in jaws of scarcely half the size—This Cuvier call the *Ursus Arctoidens* but I shall [77] not dwell on these distinctions which they en demonstrated according to * * * laws to mark a difference of species, yet are not sufficiently obvious to strike the unpractised eye but we shall pass to a species of Bear which bears no affinity to any before described whether in a living or fossil state—

[78]

Ursus Cultridens

Among the various productions of this prolific cave this species is most distinguished—for the peculiarity of its structure and its variety—until it made its appearance in this place it was altogether unknown to the naturalists of this country who at first view pronounced it to belong to the Saurian family from the serrated beading of its edges†—and it was but little more known on the continent—2 fragments of anomalous species of Bear were found in Tuscany which Cuvier provisionally named as the Etruscan Bear—but the researches of Mr. Pentland an English naturalist of great eminence led to the discovery of an entire head in the museum of Florence which had been raised from the bed of the Val d' Arno and determined the species of the Etruscan Bear—by degrees it began to reveal itself and an analogous tooth to those previously found in this cavern was discovered in the cave of Lunel near Montpellier. The resemblance of the tusk to a blade made Cuvier change the local name of Etruscan to the more general and characteristic appellation of Cul-

+ [See Owen's "History of British Fossil Mammalia and Birds," p. 184, 1846, and "Penny Cyclopædia," Art. "Machairodus," vol. xiv. p. 245. W.P.]

tridens—Up to the present time it seems to be confined to the three localities specified in Italy, France and England—and with respect to the cave of Kents Hole it is scarce only five teeth having been found and those limited to those regions of it where the bones of the Elep Rhin are mixed up with those of carnivora—and it is curious that in that district of the cave which was usurped by the species just enumerated as its exclusive Den, it has not discovered itself—thus intimating a difference of habit from its congeners—which a survey of its characters corroborates—It is rather singular too that in the German caves which swarm with Bears it has not been seen, nor in Chudleigh nor Anstis Cove in Devon where the Bear predominates—but in the mixed assemblage of bones.

Its form is semilunar, compressed and tapering to a point [80] like a blade—and along the course of the enamel which occupies nearly one half of its entire length and assumes a fine edge, it is delicately dentated—vid. P. F Fig. 1. 2. 3†—exhibiting different views of the most perfect tooth—

The curved fang was snapped off and the hollow of the tooth disclosed which with its unworn point shows it to have belonged to a young [? young] individual fig 1. 2. 3.† The other teeth represented in the same plate‡ are truncated at their apex, and despoiled of their posterior serrature while the anterior indenture is entire—How far this serrated and tranchant forms throws light on the habits of the animal can be matter only of conjecture—

This tooth would seem therefore to have served rather as a weapon of assault or defence than for the purpose of cropping vegetables which its serrated aspect would indicate for in the latter process the internal face of the tooth would be rather worn than its point which would not have been brought into such use, or at least not violently broken as it appears in the aged specimens—The appearance of the blunted apex of the teeth bespeaks the effect of violence—the part is not worn down and polished as is the case with teeth employed in bruising vegetables but broken sharply off as if from the act of piercing its foe—But Cuvier infers from the smoothed surface of the molars in the Etruscan specimens that this species lived on fruits—as well as flesh—

The enamel is longitudinally striated, and the base of the fang is distinguished from those of the other Bears by dotted lines in strong relief—

Judging from the wear of the apex and the solidity of the

† ["Cavern Researches." W.P.]

‡ [Figs. 4, 5, 6, 7. W.P.]

fangs, 3 of the specimens belonged to adult Individuals—They are all gnawed at their base—and the young one cracked across.

There is a tendency in the unworn canines of the Hy and Tiger to a denticulated edge—but it is very faint and is soon obliterated altogether—Those teeth likewise are of a quite different form—their enamel does not cover the one fourth of the tooth the body of which likewise is double its bulk and swelling—It approaches nearest the herbivorous reptile armed with serrated grinders brought to light from Tilgate forest by Mr Mantell and which he has designated the *Iguanodon*—

In addition to the canines I have lately discovered in the same bed a small tooth about an inch long—the internal face of the enamel is fringed with a serrated border—this tooth is distinguished farther by two tubercles or protuberances at the base of the enamel from which the serration springs and describes a pointed arch on the internal surface—vid fig. 8 9.† the body of the tooth in this specimen is not compressed but rounded. whether this belongs to an inferior species of the *U. cultridens*, or simply the Incisor anterior to the canine of the large species of *U. C.* I am not able to pronounce with certainty If merely the incisor, it is still interesting as it serves to show that the serrated character is not confined to the canines and that the rest of the teeth and consequently the frame are marked by a peculiar conformation.

- [82] Hence it appears there are at least three distinct species of Bear two of which are allied to, if not identical with the *Ursus Spelæus*, and *U. Priscus* of the German caves—and the third identical with the Bear of the Val d' Arno and of Lunel near Montpellier—

The {combination} {coincidence} of these three distinct species of Bear assures us that species the *U. Cultridens* which has inhabited the southern regions of Italy and France coexisted in Britain with that gigantic Bear which left its remains buried in the caves of the north over a tract of * * * leagues—and serves to strengthen the conclusion derived from the presence of the Elep and Tiger in the same beds with the Rein Deer, that the habits of those animals must have been different from the existing races, formed to {asso-

† [Not in "Cavern Researches," but amongst the plates recently presented to the Torquay Natural History by Mr Gardner who obtained them from the late Mr C. Kilby, executor of Mr Mac Enery, there is one containing five figures, of which three are without doubt different views of the tooth described by the author. Besides the figures, there is nothing on the Plate except the words "I Scharf del 1837." W.P.]

ciate} {coexist} in the same climates together—and it will [83] naturally follow that as those different species of Bear are all alike extinct whether in Italy, Germany or France—and that as their remains appear in the same debris lodged in caves or spread over the surface that they must have perished simultaneously in those respective countries—Thus furnishing in their fossil state an analogy in their fate, which may be with equal justice extended to their living condition.

Inferences from Cultridens

[84]

That it lived in the vicinity of the place where it is interred cannot be an instant doubted—removal in the medium of the loam would have been necessarily attended with the fracture or rounding of its delicate and fragile blade—The occurrence of this curious species among numerous remains of various ruminants and carnivora unfolds a complete analogy between the former population of this country and of the warmer climates of Italy and France—and that those countries were so constituted that the[y were] habitable by the respective inhabitants of the Torrid and frigid zones.

Proof of its being an Extinct Species

The U. Cultridens is referrible to no known species, nor is there any historical record or trace of its existence in modern times even in those places where its remains lie buried—The decided difference therefore from all living species, and its occurrence only in a fossil state assigns to it a different class—and this fact throws an additional weight into the {probability} {argument} deduced from the peculiar structure of the other Quadrupeds from the modern population of the Globe—Hence it has been justly observed by the greatest naturalist of any age—that whatever resemblance certain of those species bear to those of our days, it cannot be disputed that the general mass had at the epoch of the catastrophe which destroyed them a very different character—and that the greater part of the races which composed it are utterly extinct—

We are authorized to infer that the cause which extirpated [86] it in England, and buried its remains in this cave, was not a partial agent operating on an insulated district, but an universal and contemporaneous movement attended with similar effects in Italy and France—The material which envelopes it in these respective countries is the same (allowing for the local difference of the soil and strata), being composed of the immediate mould of the surface mixed with the debris of the

contiguous rocks. In their circumstances too they assimilate, it is found alike in superficial coverings whether of caves or land and the paralel is rendered complete by the presence of precisely similar quadrupeds in association with it. In the cave of Lunel they were sheeted over with a crust of stalagmite as in Kents Hole. These different localities reciprocally explain each other—The diluvium of the Val d' Arno is connected by it with the diluvium lodged in the basins of Kents Hole and Lunel—

Its dissemination consequently thro the sand and gravel in the bottom of caves and vallies taken in conjunction with the other attendant circumstances demonstrates the identity of the agent in these widely separated parts, and from the progress of Geol[ogical] inquiry and collateral evidence the sphere of its operation has been found more and more to enlarge coextensively with the face of the Globe itself

- [88] The gutters channelled out in the surface of the yielding strata—their debris accumulated in the form of gravel at the foot of vallies, at the mouths of gorges and æstuaries, and in the hollows of Caves and fissures. The dispersion of analogous gravel and boulders intermixed with bones collected in its march over widely separated tracts from Spain to the banks of the frozen rivers. From Pallas we learn that the bones of E.[lephant] and R.[hinoceros] near every considerable river in N. Asia from the Tanais to the Anadyr or nearly from the black Sea to the gulph of Kamtschatka—the existence of gravel and bones on the Altaic chains and the Himalayh peaks clothed with eternal snows—from which they fall as from the clouds in avalanches—

This accumulative evidence combine with those just recorded of this cave in attesting the operation of a body in a state of aactivity displacing the light covering of the plains by the detached fragments of the mountain intimating the action of its comprehensive force over the surface of the earth.

Nature therefore equally from her abysses and her lofty mountains speaks every where the same language—that a change has passed over the earth modifying the order of things which preceded its action and preparing the way for that which now exists.

- [90] I agree therefore with M. M. Cuvier and Buckland, who themselves follow M. De Luc and M. Dolomieu in thinking “that if there is any circumstance thoroughly established in Geology, it is that the crust of our globe has undergone a great and sudden revolution, the epoch of which cannot be

dated much farther back than five or six thousand years ago; and that this revolution had buried all the countries which were before inhabited by men and by the other animals that are now best known."†

Hyæna

[92]

The remains of the *Hyæna* next fall under our notice—and they demand particular consideration—because their condition is most marked and furnishes the most direct clue to the history of Inhabitants of this cavern and the scenes that have passed within it—

From a comparison of its characters with the living *Hy*—the fossil is found to differ from the modern in the form of its teeth and head It bears the nearest affinity to the spotted *Hy* of the Cape—

I possess of upper jaws	30		[93]
of under	70	Total	100

The greater {proportion} {abundance} of under jaws may be accounted for on the principle of the latter bones being more solid—and less practicable and inviting. Hence we find a larger quantity of single teeth and more numerous fragments belonging to the upper jaw that survived the destruction of the heads—

Jaws—mine	.	.	100
In the other hands	.	.	30
Of Posterior carnassiers of both upper and under jaws	200		
Of Molars of do	.	.	400
Of single canines or Tusks of both jaws	.	.	300
Total of single T.[eeth]	900		

I have been able to trace to different hands about thirty jaws and three hundred single teeth

The teeth and Jaws belong to animals in every possible stage of growth—From mere membranous shells with their milk teeth still unused and standing and harbouring second {sets} {series} that have not yet cut the gum, vid P. Fig.† thro all the shades of development, to the robust adult armed with powerful muscular attachments and formidable jaws vid P. Fig.§ and aged Individuals whose teeth are broken or ground down to the fangs or have entirely disappeared by absorption (Plate. Fig.)|| Cast teeth broken

† ["Theory of the Earth." § 34. See also Buckland's "Inaugural Discourse," p. 24. W.P.]

‡ [Probably Figs. 8 and 9, Plate M, "Cavern Researches." W.P.]

§ [Probably Figs. 1 and 2, Plate B, "Cavern Researches." W.P.]

|| [Not figured in any Plate known to me. W.P.]

discolord and disused and scarcely recognizable occur among the heaps of single teeth, as likewise milk teeth that have been shed.

- [94] Notwithstanding this acervation of teeth and jaws only one occiput and the entire head Plate 2† are all that escaped tolerably perfect—I possess a few fragments of the occipital ridge—The heads then which belonged to the upper jaws have disappeared—nothing left remaining of the latter in some instances, but the solid and impenetrable row of enamel even the fangs were consumed with the gums—and the holes and bruises in the very enamel show that they were not abandon^d. with^t. reluct^e. but they generally broke off at the suture—

But the under jaws exhibit one of the most curious and incontestible facts furnished by the phenomena of this interesting cave—they demonstrate the Hyænas power and method in treating its prey. The hundred under jaws in my collection are all with scarcely an exception broken at their condyles as delineated in Plate. fig.‡ The point at which the animals fearful organs pierced and divided the bone is specified at (a)§ after which process in a few instances it was again cracked horizontally and the bony part destroyed and the case of teeth thrown away—they were generally rejected—and the softer condyle instantly devoured for in no single instance has a trace of it been detected notwithstanding the strictest search, as I was desirous to possess a specimen for the purpose of ascertaining its form and size.

Bones

Bones of the several parts of the skeleton have been found and with one or two exceptions the large bones are all broken and gnawed down.

Their inferior size rendered them easy food and consequently we find only small splinters comminuted and chippings which fell from the mouth or were refused as sapless—Vid Pl R Fig 4—† and even these preserved are sufficient to fill a doz. hampers! They occurred in such quantities that the workmen could not be persuaded to save things so common and valueless—

A great portion of them are sharp angular pieces without

† [Fig. 1, Plate B, "Cavern Researches," is that of the entire head of Hyæna. W.P.]

‡ [Probably fig 2. Plate B. "Cavern Researches" W.P.]

§ [The "a" spoken of does not occur in any plate with which I am acquainted. W.P.]

marks of gnawing, but at the broken edges is visible the marks of the piercing canines which like wedges cleft the hollow bone into unequal parts.

Second gnawing

[96]

Many of these were again snatched up—broken afresh and {gnawed} {ground} chiefly at their opposite extremities which exhibit deep cross grooves cut into the bone. The inside concave surface displays holes produced by pressure against the conical teeth of u.[pper] j.[aw] while it held the bones and served as a species of {fulcrum} {purchase} during the terrible operation. Vide Plat "R." fig. 4. 9. 10.† When placed between the jaws the teeth are found to fall into the furrows and precisely similar impressions have been produced by closing the jaws on a soft paste—

On some of the bones may be traced light scratches, produced by an animal of the slight calibre of jaws such as Wolves or Fox's—which glanced off from the bone in its ineffectual efforts to break it previous to the bones being picked up by the Hyæna—From the distance between the points of the opposite canines I assume them to be rather caused by the inoperative teeth of young Hyænas which have left in the cave numerous relics—

It has been already said when speaking of Rats, weasels, and mice, that marks of their teeth like the impressions of a fine file are distinctly penciled on many of the large bones, superinduced upon deep grooves previously excavated by the {Hyænas} {larger animals} jaws.

Amid this devastation the majority of the astragali, metatarsal, and metacarpal bones and claws as usual passed unmolested—

Note respecting the Superior size of Head

[95]

Greater expansion between the orbits and elevation of occipital ridge it is nearly a third larger than the fossil head from Rugby‡ though the latter belonged to a much older animal as the teeth prove—

In the latter specimen there is a greater depression above the muzzle approaching to that observed in the Wolf Pl *** Fig ***§ which in the Kents Hole Hy is elevated and protuberant and indicating great power.

† ["Cavern Researches" W.P.]

‡ ["A plate containing a figure of this head, and formerly the property of Mr Mac Enery was recently (June 1869) presented to the Torquay Natural History Society, by Mr. Gardner of Torquay. W.P.]

§ [Probably Plate G "Cavern Researches" W.P.]

The canals of the blood vessels are proportionally larger and deeper—The character of the skull and strength of jaw impress the eye with the exhibition of great power fully commensurate with the effects ascribed to it—Deep furrows indicate the extent of the muscular action—it as large as the head of an Alpine Bear in my col[lection], but exhibits greater compass of jaw—

[98]

Solution

The obvious question and the one which starts invariably from Individuals who have beheld the assembled remains of this cavern—How came they there?—and the answer equally obvious is that Hyænas brought them there—

From whence and how could they have been able to collect such incalculable heaps—

In the first place it may be remarked that from an inspection of the remains of the Hyæna, it appears to have been longer and much more formidable than the modern—The magnitude of the head fig.† the developement of great muscular power displayed in * * * process Its forceps jaws which have been aptly compared to the machine for chopping iron {are indicative} {convey the idea} of a force capable of overpowering not merely Ruminants but even some of the fellest Carnivora—Their number is shown by the quantity of their remains Troops of these terrible assailants, (for they are known to attack en masse) would tear to pieces the young of even the large Herbivora, such as the Elep and Rhin—and this conjecture is borne out by the fact that the teeth and bones of almost all the Elep and of a great proportion of those of Rhi belonged to the young of their respective species

[100] —This is the modern case, and the scarcity of the bones of the larger Carnivora may be explained by supposing their superiority to the attacks of the Hyæna—

[106] Buffon says this savage animal lives in the caverns of mountains, in the clefts of rocks or dens which he digs for himself in the Earth—his disposition is exceedingly ferocious—like the wolf he feeds on prey—but is stronger and more daring—He rushes with fury upon cattle of all kinds—often breaks down the doors and enclosures of sheep folds—His Alys. par Rudolf. P. 41—

His eyes sparkle in the dark and he sees better in the night than in the day. Buffon says "The hyæna defends himself against the lion,† is not afraid of the panther, and attacks the ounce;"†

† [Probably Fig. 1, Plate B, "Cavern Researches." W.P.]

† [Op. cit. vol. i. p. 486. W.P.]

Such is his strength that in the island of Meroe he has been known to carry off a man to the distance of a league or two without stopping—(ibid)[†]

Laceration of Jaws

[100]

Their hostile engagements with other animals is attested by the abrupt fracture of their Canines—and as applicable to the present argument may be noticed the laceration of the scalp of a Hyæna in the possession of the late M. De Scœmmerring now in the B. Muse[um] the forepart and incisors were violently torn away and the wound subsequently healed—thus announcing their dreadful affrays with terrible enemies—and certainly animals capable of breaking the large and solid bones found in this den were formidable adversaries to the largest and fiercest tribes, especially when they prowled in a body.

Bones collected from the Plains

[102]

But tho it should be disputed whether the Hy in a body was able to overwhelm the larger animals whose bones occur here, it will be sufficient to show that the habits of this predaceous animal impel it to range the plains in quest of carrion. It is too notorious to need specifying the various writers who have recorded the habits of this animal—that it is the vulture of the forest which nightly scours the field of carnage for which purpose its sight is peculiarly adapted, vid “His eyes sparkle in the dark; and he is said to see better in the night than in the day.” Buffon † “Sepulchra effodit humanæ avida carnis.” Arist. His. Amin. Lib 8, Cap 5

Victims of Other Beasts of Prey

[104]

In a country which the numerous remains attest to have been filled with a dense population of the inhabts. of the forest, frequent and fatal must have been their conflicts—The young overwhelmed by the old—the feeble by the strong—the timid Deer—unwarlike Horse and Ox, gored by the Hy or Wolf—and these in their turn subdued by superior might After the fury of hunger is appeased the Lion is known to desist—and leave the offal of his table to meaner beasts—The Lion says Buffon kills no more than necessity demands—he leaves the remainder to the jackall &c—The Tiger though gorged with blood still goes on rushing on every living thing—wantonly gratifying its implacable enmity to life§—

† [P. 487. W.P.]

‡ [Op. cit. p. 486. W.P.]

§ [Op. cit. pp. 460 and 470. W. P.]

and the testimonies of travellers coincide in relating the awful and mortal combats of the Elep and Rhin.

- [105] Now the loathed refuse of other carnivora—the thousand carcasses and portions of carcasses scattered over the plains, of oxen, Horse, and Deer—furnished ample provisions for the Hy, whose predilection for putrid flesh and bones is unquestionable. Cuvier shews that the form of its Teeth is better adapted to breaking bones than tearing flesh—The claws and teeth [of the] feline kind on the other hand are fitted for seizing and delacerating flesh.†

- [106] *Mortality.*

Superadded to which among such numerous herds of all species the mortality may be assumed to have been great.

The combined ravages then of violence and natural decay contributed to cover the fields with numerous carcasses which the Hy impelled by its inherent predilection for putrid flesh, scented from afar, tore to pieces dragged to the mouth of its den or carried into its dark retreat to devour unmolested at leisure.

- [108] *Conclusion from the above*

It must appear evident therefore that from its own prey conjointly with the refuse of other animals and the ravages of death among such numerous hosts of Quadrupeds there were abundant remains for these depredators of the forest to collect† to carry into their dens and devour in the day time till night invited them to the pursuit of fresh forage—

Upon a review of specimens of broken bones from this cavern Baron Cuvier came to this conclusion—and many persons of science who had been incredulous before from the evidence exhibited by this cavern came to the decision of Professor Playfair respecting the phenomena of bones in the German caves§—that it served as the den and the tomb of a whole dynasty of unknown monsters that issued from the central spot to devour the feeble inhabitants of the woods during a long succession of ages, before man had subdued the earth and freed it from all dominion but his own—Page 460

† The Hy is much less carnivorous than the feline kind—hence they seldom eat flesh till it putrifies and is thus more easily separated and what is in perfect harmony with the great thickness of the teeth is the extreme facility with which they break bones however hard. Cuvier Oss. F.

‡ The number of cast horns shews that the bones had been collected from the surface of the plains—out of the entire number only 6 retained portions of the frontal bones—two torn from the skulls—all the rest are smoothed at the base of the horn as is the case with shed horns—

§ [See "The Works of John Playfair, Esq." 4 vols. Edinburgh, 1822, vol. i. Note 22. W. P.]

Album Græcum

[110]

And if a doubt still exists as to this fact of this occupation of the cave by Hy it must yield to the great abundance of thick osseous excrement—It occurs mixed up with the diluvium, or in insulated balls and heaps among groups of bones—I possess masses of it investing them even in breccias but in what has been designated the cloaca maxima—particularly at a distance from the grand depot of bones its quantity is almost incredible, only proportioned however to the consumption of the bones ascribed to the Hyæna.

The Cave would appear to have been occupied up to the moment of the entrance—otherwise the bones and A[lbum] G[ræcum] had not preserved all their freshness.

And tho it may be true of the Bear and of Rodentia whose bones occur entire and unmutilated, that they fled hither at the approach of the inundation of mud—it would be absurd to suppose that violence impelled hither the large Herbivora, the Elep. R. and Horse, even admitting that the apertures were sufficiently large to afford them access to the interior—In this case we should expect to find their remains entire and lying in their natural juxtaposition—The same envelope which protected and embalmed the most fragile and delicate specimens, would have assuredly preserved them—we must look for some other cause for their presence and [111] every circumstance comes with accumulative force to demonstrate that cause to be the agency of Hyænas—

Feline—Tiger—

[112]

In enumerating the remains of the Feline kind, we cannot help remarking the comparative scarcity of its bones—they are however more numerous here than in many other caverns—in Kirkdale only one canine at all referrible to this species has been found—and even this according to Cuvier does not belong to the Tiger—There have been found a dozen canines—and about half the number of molars—vid P. E. 5, 6, 7†—and also a fine upper jaw the property of Sir L. V. Palk Bart. Vid Pl. C. Fig. 1.†

The canines are of two sizes and from their having attained full maturity seem to belong to two distinct species.† the large Pl. E. Fig 2† coinciding in size with the Bengal Tiger or Lion. the inferior tooth [Pl. E. Fig.] 1, of inferior magni-

† [“Cavern Researches.” W.P.]

† The large belongs to *Felis spelæa* of M. Goldfuss—the small one to “*antiqua*” of Cuvier.

tude with Panther? or Jaguar of South America the third in size according to Blumenbach * * *

Two under jaws of a small species larger than the common cat have made their appearance—The smallest is fig—Vid Pl E. Fig 18—†

Feline are generally distinguished by an indentation in the Canine, strongly marked in the Lion, Tiger, Panther, and Pard—very faint in Cougars—Jaguars

There have been found a few bones of Feline.

[113]

Query

To what is the scarcity of the Feline species to be ascribed—was it less numerous in those times—or was the Lions superiority of strength his shield against those ferocious assailants of the forest before which so many less powerful fell. Under circumstances of natural decay we should expect the Hy. would drag forth his remains from the most secret haunts unless deterred by the presence of the *living* Tigers—Those that were accessible we perceive have not escaped the jaws of this common carrier of the dead which dragged them indifferently with those of the shrinking deer into this universal sepulchre of the most uncongenial and incompatible species.

Blumen. says that the bones of a large species were found in Hanover near Osterode in company with those of Hy. and Elep.

They occur both species in the caverns of Hungary, Scharfels, Gaylenreuth Aldenstein and the breccia of Nice—The tusk of one was dug up with bones of Horse in Paris.

All these species require a warm climate—never known in the North—Buffon denies their existence in N. America.‡

Lions are as rare in Asia as they were formerly abundant—The thousands exhibited at the Roman spectacles present a singular contrast to the straggling one occasionally met with.

[114]

Wolf

Only four canine and as many molars of the wolf have been noticed exclusive of the magnificent head of fig Pl G.§

I am not aware of the existence of any fossil head of equal magnitude and preservation—Every part was perfect when discovered—but the bones of the zygomatick arch were lost thro the negligence of the workmen—we have already noticed

† ["Cavern Researches." W.P.]

‡ [Op. cit. pp. 451, &c., and 455, &c. W.P.]

§ ["Cavern Researches." W.P.]

that at the distance of a few paces its under jaw was found in the Idol cave about a year before the head was discovered.

Kirkdale produced few of its remains—Oreston one under jaw or two—which Mr Clift has described and fig in the Phil. Trans.†

Gaylenreuth has been most productive—

Fox—Jackall

The number of jaws (all under) may be computed at 20— and about as many more tusks—No doubt that many more thro the negligence of the workmen and minuteness escaped in the mud—In Plate E. Fig 14‡ is represented the most perfect under jaw of Fox in remarkable freshness it is the constant companion of the Bear, Hy &c. They are generally of a bright white and fresh color—others stained—

[END OF FASCICULUS D.]

[According to the "Index," it extended to "Page 123" and contained descriptions of "Weasel, Badger, Hog, Hare, Rab, Lagomus, Rats, Mice, Bird." W.P.]

† [Phil. Trans. 1823, Part 1, p. 87-8, and Pl. 12, fig. 10. W.P.]

‡ ["Cavern Researches." W.P.]

[FASCICULUS E.]

[1]

ELEPHANT.

River Lena

A FOSSIL Eleph was discovered in Asiatic Russia in 1799 in the actual condition in which it died in a state of absolute integrity. This discovery was made by a Tungusian fisherman near the mouth of the River Lena and in an iceberg like those bones found near Behrings straits by Lieut. Kotzebue.† By the detachment of a mass of the iceberg a portion of the carcase was exposed—and during the two following years the ice had so far dissolved, that a great part of the carcase came into view, In 1803, five years after the first discovery, the Tartar hunter and fisherman who still continued to watch, (it being inaccessible from its elevated position in the ice cliff) perceived that the ice was fast thawing round it so that it at length fell down and lodged in an accessible part of the shore—they then abstracted the tusks and sold them—after that it was examined by Mr. Adams—but as it was after a lapse of two years, the dogs of the natives had nearly devoured all the flesh and one of the fore legs had been already carried off by the white Bears—But the rest of the skeleton still remained and the parts were kept together by the ligaments and remnants of the skin—The head was so entire that the skin still covered it, tho it was dried and shrunk—Even the eyes were tolerably preserved as was one of the ears which was found to be covered with a tuft of strong bristles—The under lip had been eaten off with part of the upper one, a long mane extended along its neck composed of stiff black bristles more than a foot long—The skin was very thick and heavy covered with bristles of a reddish brown. There was a considerable quantity of a coarse wool of the

[2] same color, the under lining of wool which lies next the skin in all the animals of cold climates—and it serves to show that the Siberian and probably all the fossil Elep were indigenous to the country in which they occur in a fossil state. The Elep of our day inhabiting hot climates are nearly naked—only a few long bristles scattered sparingly over the skin.

† [“Voyage of Discovery,” &c., vol. iii., pp. 298-9. W.P.]

It was a male.

[The] Ancients imagined the Elep had no joints, being [3] unable to lie down slept leaning against a tree.

Temperature reduced.—

[2]

Of the Arctic seas but little is known, of the Antarctic still less—We may anticipate then, that future Parrys and Franklins will illustrate the age of other Barrows by pushing still further the career of discovery in these untravelled fields of ocean—How I would ask does Dr. Fleming consider it probable that among the interesting novelties to be detected by their researches they will astonish the naturalists of those days by accounts of new Islands discovered in those frigid seas surrounded by Coral reefs, amidst which turtles are disporting themselves in such quantities that aldermen might long to colonize the happy shores, the interior overshadowed with forests of arborescent ferns and palms; the breezes fragrant with spices as those of Ceylon; Lions Tigers and Hyænas roaming the jungle; Elephants and Rhin stalking over the plains, the Rivers teeming with Crocodiles and haunted by Hippopotamuses?—

Eleph. Osteology.

[3]

Independently of the differences in the structure of their teeth, the fossil and modern species are further distinguished by the characteristic structure of the head arising from the form of the {face and trunk} {Physiognomy}.

In the fossil animal the alveoli of the tusks are much larger and the zygomatic arch of a different figure.

The Posorbital apophysis of the frontal bone is longer—more pointed and more crooked and the tubercle of the os Laycramalis is considerably longer and more projecting—Besides which there is greater parallelism in the molares—The vacuity (space) between the branches of the jaws at the forepart is wider, than in the Asiatic or African Eleph^t—In them the lower jaw terminates in a kind of pointed apophysis, but in the fossil individual it is rounded off to prevent collision with the alveoli—

“There is in this Universe a Stair, or manifest scale of creatures, rising not disorderly, or in confusion, but with a comely method and proportion.” Religio Medici 33.†

Though in the present state of science, notwithstanding its recent strides, we cannot supply all the links that insensibly

† [“Religio Medici.” By Thomas Brown, Knight, M.D. 7th Ed. 1672. § 33, p. 26. W.P.]

connect every branch of animal and vegetable life from the simple monad to the most consummate organization—a few years will in all probability reveal many of the missing knots of connection in the scale of structure—as has been already done in the discovery of the ornithorhynchus intermediate between a bird and Brute, with the beak of a bird and feet of a Quadrup[ed]†—fill up those chasms by insensible gradations of form which now interrupt the continuity—such also the Hyæna dog—Mastodon—

- [4] The Elep^t being herbivorous its teeth wear down by mastication like those of all animals subject to the same law. They are thus prepared for grinding vegetable substances—The convex summit soon assumes a disk like form studded with {rings} {insulated circles} of enamel forming a {line} {range} across the surface of each abraded plate—when the process of detrition operates on the body of the tooth, the separate rings reunite into one continuous band encircled by double parallel lines of enamel.

From its Rhomboidal form the tooth presents much more of its anterior surface to mastication than of its posterior—and when the anterior plates are worn down ready to drop out by absorption, the posterior plates remain as yet untouched with their prominent digitated summits—so that the anterior plates are destroyed before the latter are brought into action—and hence the phenomenon peculiar to the Elep that its teeth diminish in length at the same time that they diminish in size

During the destruction by wear of the upper surface, the corresponding portions of the root diminish in an unaccountable manner, as if by the corrosive action of an acid—and each tooth no matter how large before, at its shedding dwindles to nothing.

- The new tooth composed of separate laminæ moves forward plate after plate until it completely pushes out the old tooth—Hence it will be seen that the removes do not shoot up at the base of the shedding teeth as is the case with those of other animals—but [ad]vance laterally from their recesses in the back of the jaw—during the operation of masticating, the single plates composing the teeth are consolidated into a solid mass held together by a girdle of bone that gradually invests them during detrition
- [5]

Number of the Teeth

The Royal Soc. first discovered in 1715 that the number of

† [Part of the leaf torn off. W.P.]

the Elep teeth varied from 1 to two on each side—but Pallas was the first to show their mode of succession—at first they have but one on each side—the second in advancing pushes forward the first, so that for a certain time there are two—The fall of the first then leaves only one in the jaw.

Mr Corse informs us that the teeth go on changing to eight times—and that consequently 32 teeth may successively occupy the jaw. The first set appears eight or ten days after birth, are all formed in six weeks and complete in 3 months—

The second series are completely completed in 2 years. The third appears at this period and {cast out} {discharge} the second set in the 6th year and they in turn are supplanted by a fourth remove in the ninth year, beyond which period their progress is not ascertained—

The number of the plates in each tooth goes on augmenting—each succeeding tooth has more than the preceding ones—

The first or milk set has only four plates—The second eight or nine—The third a doz. or 13—

Each new tooth takes at least a year more for its formation than its predecessor—and so on to the seventh or eight tooth [6] which has generally 22 or 23. Mr Corse never observed teeth with more—

The removes take place at longer intervals proportioned to the animals advance in years.

The plates are thinnest in the young—

Even in the full grown tooth no more than 10 or 12 are generally brought into use—

The fangs of the Elep Teeth like those of all other animals do not grow till after the body of the tooth is perfectly formed Phil. Trans. Tom. 29. No. 349. P. 370

One of those grinders can never be procured in a perfect state for if its anterior part has not been at all worn the back is not completely formed and the fangs in particular are wanting while the structure of the back part is not completed until the anterior portion has disappeared.

Besides the lozenge form which the enamel lines in the African tooth assumes, its plates are thicker—10 or 12 will occupy as much space as 15 of the Indian—a less number consequently goes to the tooth—

No African tooth is known to possess more than 10 plates. Those of the Indian have 23 and 25.

The ears of the Indian species are of a moderate size—Those of the African depend to the ground over the shoulder—a similar kind of succession has been ascertained to obtain in the *Sus æthiopica*

[8]

Rhin

The adult has 28 teeth—7 in each jaw—The term of its gestation is 17 months—its horn takes a long time to form—

Mr Hodson in a paper read before the Asiatic Soc 1825—has had occasion to remark the amiableness of a young Rhinoceros disposition “both towards its keeper and strangers; an instance, he observes, of the power possessed by Asiatics, thro their tranquil familiarity, of taming the most formidable quadrupeds. That the rhinoceros will submit to the domesticating influence of man we have seen more than one instance, nor would the tractability of this herbivorous animal seem in any way a matter of surprise, when we know that the fiercest of the carnivorous tribe have become the attached companions of their master, if the rhinoceros had not been held up by writers of every age and country as a standard of brutal and untamable ferocity.”†

[9] The Rhin has been known to rip open horses—the horn of one penetrated through the saddle and fractured two ribs leaving a wound thro which the hand might pass—

It is the inveterate enemy of the Elep attacking whenever he can find them single or at least not protected by a male of great bulk, ripping without mercy and confiding in his coat of mail to defend him from the puny attacks of the Females, as well as to resist the teeth of the young males.

From the testimony of credible witnesses and from the circumstances of Elep^t having occasionally been found dead, obviously from wounds given by the Rhin and above all from the circumstance of a R and a large male Elep having been discovered both dead, the Elephants bowells being ripped open and the R transfixed under the ribs by one of the Eleps teeth—no doubt can exist as to the dreadful conflicts between these two stupendous combatants—

Major Lally was witness of one of these {encounters} {engagements}, the Elep was protecting a small herd which were retiring in a state of alarm—The E. was worsted. (Williamsons Oriental Field Sports Vol 1. P. 165)

[29]†

Popular errors respecting the Hyæna

Aristotle corrected the prevailing error respecting the union of both sexes in the Hyæna—by the ancients the Hy was not

† [See “The Asiatic Journal,” vol. xxii., 1826, p. 196. W.P.]

† [Pages 11 and 12 contain memoranda to be given in Fasciculus J. Page 13 is blank. Pages 14 to 27 inclusive are missing. W.P.]

merely a Hermaphrodite, but was supposed to change its sex annually—(*Pliny* 8-3.)

It was imagined that it had the talent of counterfeiting the Human voice and called men by their names—(*Id. ibid. et Elien* VI and III. 7)

The Turks of the present day deal still in the marvellous in their reports of its habitudes—(*Vid Busbie—Itener—Constantin and Amas* P. in. 76. 77)—†

It is notorious that it was imagined to have but one vertebræ along its spinal column—and that the atlas of the neck was consolidated with the head—errors arising from the display of its muscular prowess—

The Romans were slow in introducing the Hy. in their spectacles Gordian the III was the first and the only one of the emperors who is recorded {as having} {to have} exhibited them—

Ten appeared at the Philipian games in 1000 of Rom.—or 247 of J[ulius] C[æsar].

Hyæna—Description of Striped and Spotted

[30]

The muzzles of both the striped and spotted are short and turned up—ears large and nearly naked.

Their size is about equal—varying from three feet four to 5½ in length and two feet and a half high. Both are remarkable for their limping motion which gives them an appearance of lameness—

The striped is distinguished by a long mane which flows down the necks flanks and haunches—which is wanting in the spotted—

It has always as its name indicates, the skin marked with transverse bands, brown or black upon a brownish grey, yellowish, reddish ground The neck and throat jet black. a blackish {tint} {streak} extends along the spine commencing from the bristling points of the mane, and prolonged to the tail. The hide is composed of two sorts of hair—the fur or wool in very small quantity and the silky hair, long, stiff, and not very thick, excepting on the limbs where the hair is short and close and on the muzzle which is quite shaven as well as the external face of the ears, the hair along the spine is much thicker and stronger than on any other part particularly on the withers forming a sort of mane as above.

The spotted is a native of southern Africa, is found in numbers at the Cape of Good Hope—hence Desmarest named

† [“Travels into Turkey. Translated from the original Latin of the learned A. G. Busbequius.” London, 1744, pp. 63-4. W.P.]

it. a general resemblance to the striped, but smaller, mane less full, color dirty yellow.

The spotted has only annular spots brown or black and more or less apart on its thighs, which on the shoulders blend into a band that descends down the belly.

The hair of its back is by no means long nor capable of standing erect into a mane—Extremity of its muzzle black—tail brown with spots.

The striped species is a native of the Levant—The striped is a native of Egypt, Barbary, Abyssinia, Nubia, Syria, and Persia.

The spotted comes by the Cape of Good Hope from Southern Africa—Aristotle described this variety with great accuracy—Pliny fell into the popular prejudices of its neck consisting of one bone without joints. it was supposed to possess great virtue in magical invocations and the Arabs to this day bury the head to prevent its being employed as a charm against their safety and happiness—The Greeks and Romans believed, [31] too, in its power to change its sex, that it aped the Human voice (whence the character of “laughing” applied to it) that it had the power of fascinating the shepherds to the spots and thus seizing them as serpents do birds—

A native of warm latitudes its habits are like those of the vulture and Jackal—it draws its support from those animal remains which if unconsumed would pollute the air with putrescence—all the narratives of Residents agree in this statement. Mr Pringle in the notes to his Ephemerides states “There are several species of the vulture in South Africa but the most common is the large light coloured *Vultur perenopterus* one of the sacred birds of the ancient Egyptians. These fowls divide with the hyænas the office of carrion scavengers, and the promptitude with which they discover and devour every dead carcase is truly surprising. I have seen a large ox so dexterously handled by a flock of these voracious fowls that in the course of three or four hours not a morsel except the bones and the skin, which they had contrived to *disincarnate* almost entire, remained for the Hyænas. In a field of battle in South Africa no one ever buries the dead, the birds and beasts of prey relieving the living of that trouble. Even the bones, except a few of the less manageable parts find a sepulchre in the voracious maw of the Hyæna.”

The Hyæna possesses the faculty of smell in as high a degree as the vulture does that of sight which enables him to descry a carcase from afar—Major Denham says “the Hy came so close to the tents last night that a Camel which lay

about a hundred yards from the enclosure was found nearly half eaten. A lion first made a meal on the poor animal when the Hy. came down upon what he had left"—

Mr. Burchell says, "A new species of Antelope which had been shot by Spellman late on the preceding evening, was fetched home; but during the night the hyænas, or wolves as they are called by the Boors and Hottentots, had devoured all the flesh; leaving us only the head and the hide."†

From these and other multiplied instances it is clear that [32] in these regions, in the very hour that any quadruped falls the sharp-scented Hy immediately descries it and rush into the encampments of men for their share of the carcase—At the Cape they formerly came down into the town unmolested by the inhabitants to clear the shambles of their refuse, which gives strength to the common notion that they tear newly buried bodies out of graves—and that in their voracity they spare not their own kind.

In the intensity of hunger the Hyæna will invade villages, carry off large animals and human beings. Major Denham says "at this season of the year," (August) "there are other reasons besides the falls of rain which induce people to remain in their habitations, . . . the hyænas," (of Bournou) "which are every where in legions, grew now so extremely ravenous, that a good large village, . . . had been attacked the night before my last visit, the town absolutely carried by storm, . . . and two donkies, whose flesh these animals are particularly fond of, carried off in spite of the efforts of the people. We constantly heard them close to the walls of our town at nights, and on a gate being left partly open, they would enter, and carry off any unfortunate animal that they could find in the streets."‡ He may be traced among the ruins of ancient greatness and splendour the places of the Ptolemies and Cesars—over which his presence throws a deeper shade of desolation and solitude—

Fossil Hyæna

[33]

The fossil Hyæna was about a third larger than the striped species with the muzzle in proportion much shorter and stouter. The teeth as to form resembled those of the spotted species, but they were considerably larger—The power of the

† ["Travels in the Interior of South Africa." By William J. Burchell, Esq. 1824. Vol. ii., p. 277. London. W.P.]

‡ ["Narrative of Travels and Discoveries in Northern and Central Africa." By Major Denham and Captain Clapperton, vol. i. p. 187. London, 2 vols. 1826. W.P.]

animals, particularly in its faculty of breaking bones was therefore considerably greater than those of the existing races—

Armed with a tremendous machinery its jaws acted like iron shears in parting metal, cut thro the hardest and most stubborn substance.

Teeth made for tearing and cutting flesh and fitted into jaws of great strength incapable of lateral motion but closing together like a pair of shears.

The structure of the stomach of the Lion is more simple than a Hyænas—the reason is that the one prefers to seize a living body for its food—the other is attracted by a putrid carcass. In the Lion and Tiger who devour their victim before absolute death has taken place, while the flesh is not yet set and the blood still warm, the stomach is of the most simple form—the gastric juice of that organ being sufficient for the work of digestion, it needs not the complicated process indispensable to animals that eat grass the most indigestible of all substances—

[36]†

Wolf

The ancients imagined that the neck of this animal like the Hy^a consisted of one solid bone. Notwithstanding the promises held out by the laws of king Edgar for the extirpation of the wolf in England and Wales in 1281 these animals infested several English counties, but after that period our records are silent about them. The last wolf seen in Scotland was killed in 1680—and in Ireland in 1710—

The wolf still inhabits the continents of Asia, Europe and America—In the least inhabited parts of N. America they assemble in large droves and hunt deer and other animals like hounds with hideous howlings—and it is affirmed they attack even the Buffalo—In some parts of Europe their number has increased as in Sweeden where they were rare till the year 1720—

France was so infested with its ravages in 1764 that Public prayers were offered for the extirp. of the race—

The wolf is distinguished from the Dog in the time of its gestation which in the latter is only 60 days—which in the wolf is 100—an error.—longer head—nose pointed larger, greater strength of limbs and muscle but the accurate Cuvier after the most careful comparison of their ost. character confesses that the wolf and mastiff can scarce be distinguished—and after remarking some subordinate shades of difference

† [Pages 34 and 35 are missing. W.P.]

which may exist among individuals of the same species, he is disposed to refer the Dog and wolf to the same stock—if the specific diff. of the other accompanying species did not intimate the probability of distinctive character in this species also—and if these differences are not sufficiently refined—so neither is the identity of the wolf and Dog—

Whatever may be the result of more extensive researches it is certain that the Wolfs bones are found in the same locality in the same bed—under the same crust, exhibit all the characters in common with the other fossil species and therefore claim the same antiquity and inhumation as they do—

The average height is about 2 feet six inches before and 2 [37] feet four inches behind and the length of the body from the tip of the muzzle to the insertion of the tail 3 ft. eight inches. gestation 63 days—8 or 9 at a litter,—in these respects resembling the Dog—

Of all animals the Wolf inspired greatest terror in Britain, The month of January owed its ancient designation to the circumstance of the wolf being more dangerous in that month than in any other—"for that, through the extremity of cold, and snow, those ravenous creatures could not find of other beast sufficient to feed upon" (Verstegans Restitution of English Antiquities [p. 59] "Hence the first month was then called "Wolf monath"—Their fear of this animal gave rise also to superstition and sorcery—The terror of its name like that of the Lion suggested itself as an appellation for Kings and nobles in a barbarous age who affected its terrible qualities—Among our Anglo Saxon Kings and great men we find Æthelwulf—the noble wolf—Berthwulf, the illustrious W.—Eadful—the prosperous W.—Ealdwulf, the old wolf—Brute force being then considered the highest praise of man.

King Edgar in the 10th cent tooke order for the destroying them throughout the whole realm. The Welsh paid tribute to Edgar which he commuted for 300 wolf's heads—Malmsbury says the tribute ceased on the fourth year for want of wolves†—Hollingshed says that in 1577 wolves were very destructive to the flocks in Scotland‡ and it is stated that the last of this ferocious race perished in Lochaber by the hand of Sir Ewen Cameron about a century afterwards—They were exterminated in Ireland at the beginning of the last century.

(Its supposed predilection for Human flesh occasioned the

† [William of Malmesbury's "Chronicle of the Kings of England," b. ii., c. viii., p. 168, Bohn's Ed. W.P.]

‡ [See Hollingshed's "Scotland," chap. viii. W.P.]

idea that it was possessed by an evil spirit or Demon more fearful than even its own insatiate appetite)

[38] In the southern countries of Europe wolves are now rarely seen—In severe winters they appear in France and in Germany, several were seen in 1818 in the forests near Boulogne. In Spain the sheep dogs wear spiked collars round their necks to protect them from the assaults of the wolf—

In the northern regions of America—it is very formidable—sometimes measuring six feet from the muzzle to the end of the tail (Brokes Travels) Their prevailing color is light with a silvery black stripe from the nape of the neck along the back—White wolves occur on the shores of the Polar sea—The loss of color is probably attributable to the rigor of the climate—though Desmarest thinks it a specific variety belonging to the class of animals called “Albinoes”—recent investigations go to the identity of the substance which gives color to the skin and hair and that which regulates the ability of the animal to endure changes of temper^e and light, without which faculty it would perish mid cold and darkness. The *black* wolf is found in the southern states of America, very fierce and untameable in their natures.

During the arduous journeys of Cap Franklin to the shores of the polar sea he and his companions were often compelled to dispute their scanty meal with the prowling wolf—On one occasion when they had killed a moose deer and had buried a part of the body, the wolves absolutely dug it out from their very feet and devoured it while the weary men were sleeping†—but the wolf was sometimes a caterer for the hungry wanderers—when a group of wolves and a flight of crows were discovered the travellers knew there was a carcass to be divided and they sometimes captured it from its ferocious possessor.‡ Dr. Richardson says that “having the first watch, he had gone to the summit of the hill and remained seated, contemplating the river that washed the precipice under his feet, long after dusk had hid distant objects from his view. . . . He was roused by an indistinct noise behind him, and on looking round perceived that nine white wolves had ranged themselves in form of a crescent, were advancing apparently with the intention of driving him into the river. On his rising up they halted, and when he advanced they made way for his passage down to the tents.”§

† [Franklin's “Narrative of a Journey to the Shores of the Polar Sea in 1819-20-21-22,” p. 172. W.P.]

‡ [Ibid. p. 327. W.P.]

§ [Franklin's “Narrative of a Journey to the Shores of the Polar Sea in 1819-20-21-22,” p. 344, 1823. W.P.]

The crescent is the line into which a pack of wolves form [39] themselves in their plan to enclose their prey, and frequently they drive it before them down a precipice where they seek and devour it at leisure.†

The American varieties burrow far from the haunts of man in inaccessible situations—She lines her den with moss and her own hair—during her suckling her young for 2 months she is supplied with food by the male—They feed the cubs with half digested meat which the parents themselves disgorge. The Fox is so distinguished for the care of her young.

Glires‡

It has been already stated that many of the specimens were encrusted over with a breccia composed of the skeletons of glires—tho the matrix of the remains is a bright sandy loam similar to that in the open chamber it undergoes considerable modification of colour in this case—from the intimate intermixture of an infinite congeries of their bones it assumes a dusky appearance—Though there no quarter of the cave where they may not be traced in this§ they {seem} {might be said} to constitute the very basis of the deposit and it is remarkable that they occur in such incalculable numbers, only in the midst of the great magazines of the large bones in this and the adjoining great chamber—Bat, Weasel, Lagomus and mole are occasionally distinguished in the heap—But Land and Water Rat, Shrew and field mice are crowded in thousands, the bones and jaws all tolerably perfect—in the state that those of modern may be traced between the rocks on the floor above—

That they were contemporary with the animals among whose remains they are found scattered—and that they co-existed here with the beasts of prey which {deposited} {collected} the bones here is clear—

1 The skeletons of those which had previously perished, were insinuated into chambers of the large bones and heads into which the fluid impelled *them*.

2 Marks of nibbling are visible on most of the large bones—and comminuted splinters are found to accompany the remains in the same heap—which must have taken place prior their inhumation, as they are found buried along with

† [Ibid. p. 100. W.P.]

‡ [The following account of the Glires and of the Nuts is copied from a loose leaf, written on both sides, but not paged. From the size and quality of the paper it probably belonged to this fasciculus. W.P.]

§ [In all probability the author is here speaking of that branch of the Cavern which elsewhere he terms the "Cave of Rodentia." W.P.]

the other substances in indurated loam at depths inaccessible to modern animals—

3 It follows that they were attracted hither in thousands by the offal of the large animals on which they preyed which they probably dragged down into their hiding places—and others may have retired hither to die as is the custom with their congeners of this day.

4 The circumstance of their occurring entire and in heaps in this section may be thus explained. At the time of the descent of the mud they fled towards and congregated in their cells where they were overwhelmed under the loam. At the same time the skeletons of those which previously died were entangled and disseminated thro the agitated fluid and thus insinuated into the cavities of the bone and crevices of the rock. This solution may apply to their occurrence under similar circumstances in Anstis cave—and also to those in Kirkdale. Their congregation may be considered as an additional argument of the undisturbed occupation of the cave by generations of small as well as large animals prior to the inundation of the cave—

In confirmation of their residence in this cave we must not pass over the occurrence of Hazel nuts {in} {among} this mass—Single nuts detected in the heart of the undisturbed loam. There was no reason for supposing them of posterior date to the Glires, whose food they may have once formed—They were pierced at one side and the place of the kernel was filled with the red loam—

There were found nests of nuts hoarded up along the sides of the fox holes before mentioned—at first view they were supposed to have been contained in the stomach of some large animal that lived on vegetables and that they survived their frail integument as was the case with the branches found in the cavity of the stomach of Mastodon in North America—but farther observation inclines us to refer them to modern animals—they are better preserved and not charged with loam like the single ones—Their lying in the track of modern rats is sufficient to {account for} {explain} the manner of coming together. Had they been of equal antiquity with the former they could not have escaped in clusters—but must have been dispersed like the single nuts which may have been anteriorly to the agitation collected too in clusters.

These circumstances indicate their comparatively modern deposition introduced by beasts which finding access thro the fox holes to the body of the diluvium then concerted [?]

hoarded up the fruits collected at the mouth of the cave where they at present grow.

The nests of nuts are much better preserved than the single ones and appear to have been collected by the small animals whose skeletons we find under every rock we turn up on the floor.

Both descriptions of nuts are pierced at one end thro which the kernel was extracted.

[END OF FASCICULUS E.]

[FASCICULUS F.]†

[1] PROCESS OF GROWTH OF ELEP. TEETH—CUVIER—

EVERY molar of the Elep^t. as indeed of all teeth is produced or conceived in the interior of a membranous sack, which with the majority of antams [? anatomists] we shall call its capsule—This sack seen externally is of a Rhomboidal form, less high behind than before; it is closed on every side, excepting the aperture for the passage of the nerves and vessels—hollowed out in the jaw bone and which is to form one day the alveolus or gum of the tooth. It is only the outward plate of the capsule which possesses the simplicity of form we have described—its internal plate or surface makes, as in herbivorous animals in general, many (replis) folds—But to be intelligible it is necessary to describe another part—I mean the pulpy nucleus of the tooth—It has in every animal a peculiar figure—to represent that of the Elep^t. in particular, let one imagine that from the bottom of the capsule taken for a base, proceeds a kind of small walls, all parallel—all transverse—and looking to that part of the sack ready to emerge from the gum—this little walls do not adhere but to the bottom of the capsule. This opposite extremity, or summit is free from all attachment—This disengaged summit is much more fine than the base one might call it their edge. It is deeply indented along its breadth into many points or very acute furrows. The substance of these walls is soft, transparent, very vascular and partakes much of the nature of gelatine—It becomes hard, white and opaque in spirits of wine. One may easily conceive the foldings of the internal membrane of the capsule—let him imagine the elongations (productions) which penetrate all the intervals of the little gelatinous walls, which I am going to describe. Consequently one can imagine a continuous space, though very winding and doubled down on itself—between all the gelatinous partitions (descendans pour les dents d'en haut ascendans pour celles d'en bas) and these little minute membranous divisions

† [There are no means of determining the original extent of this Fasciculus as it has neither pagination nor index. For convenience I have paged it from 1 to 27. W.P.]

(*ascendantes pour les dents d'en haut, descendantes dans celles d'en bas.*) It is in this supposed space, that the matters which shall form the tooth will deposit themselves—namely, the substance, commonly called, osseous, which will be (consolidated) transsudè by the gelatinous productions proceeding from the bottom of the capsule—and the enamel which will be deposited over membranous walls and in general over the entire internal surface of the capsule and its “productions” the base alone excepted. It must be remarked in the mean time, that between the supposed osseous substance and the enamel, there is a very fine membrane, which I think I have discovered, since there is no longer any part of the substance (*de transuddè*) this membrane immediately envelopes the small gelatinous wall and presses it very close. In proportion as this little wall transuddes this substance, it shrinks, it retires within and removes itself from the membrane, which always serves, nevertheless, as its tunick, but a tunick common to it and the matter which it has transuded under it.

The enamel on its part is deposited upon the tunick [2] through the productions of the internal plate of the capsule and it compresses it in such a manner against the internal osseous substance, which it separates from it that soon this tunick becomes imperceptible in the hardened portions of the tooth or at least it does not appear but upon the border surface like a grey line very fine which separates the enamel from the bony substance, but one sees also, that it is this alone which attaches the indurated parts to the base of the capsule, for without it there would an interruption of its continuity.

The substance, called osseous, and the Enamel are then produced by a sort of juxta position. The first forms itself by beds, from the outside to the in the interior bed is the last formed—and it is also the most extensive, exactly as in shells, and its formation commencing by the most saliant points of the gelatinous nucleus of the tooth, it is at these points that it is the thickest. It goes on diminishing as it removes [?]

If one carries himself back to the commencement of this transudation, one can imagine it forming a little cap over each of the dentelures—which divide the edges of the little gelatinous walls of which I have spoken so often. In proportion as the new beds join themselves from the inside to the first the caps change into conical horns (cornets). If the new and interior beds descend to the base of the slopes of the edges of these small walls, all the cornets (horns) form one sole transversal plate. In fine if they do descend to the bottom of the little walls themselves, all the transversal

plates will unite into one solid crown of the tooth—which will present the same eminence and the same decoupures (complications?) as one observes in the gelatinous nucleus, if during the time, that the beds transude, other substances are not deposited upon them, and have not in part filled the intervals.

Enamel—

The surface of the Enamel is deposited as I have observed, upon the surface of the substance called, osseous, through the internal membrane of the capsule, under the form of small fibres or rather of small (*cristaux*) all perpendicular to this surface and there forming, in the first moments, a sort of velvet with fine points (*brins fin*) when one opens the capsule of the germ of the tooth one finds little molecules of the future enamel, as yet but slightly adhering to the internal face of the capsule and easily disengaging itself—a part even swims in a liquor interposed between the capsule and the germ.

But let us return to our Teeth—

A thick layer of enamel investing the crown of the tooth on every side, fills a part of the intervals which the transversal plates and their dentelures had at first left between them. The rest of these intervals is completely filled with a third substance which M. Tenon has named *Cortical osseux*, because it envelops all the rest and that it resembles ordinary bone by its chemical nature and its hardness, even more than the 2 other parts of the tooth. Sir Everard Home also calls it bone while he calls the substance commonly known as osseous, Ivory. Mr Blake gives to the cortical the name of *Crusta Petrosa*.

Its production has something very remarkable. M Tenon has thought it proceeded from the ossification of the internal plate of the capsule as this capsule had produced the Ivory. Mr Blake thinks it was produced by the opposite face to that which produced the Ivory.

[3]

Growth of Cortical.

For my part I think this is formed by the very same plate and the very same face which produced the Enamel—The proof of which is that this plate rests on the outside of the Cortical, as it was once outside the enamel and that it remains there soft and free as long as this cortical leaves it room—only that it changes its course. while it was forming only the enamel it was fine and transparent. To give the cortical it becomes thick, spongy, opaque and reddish. The

growing cortical is not by semi[?]filets, but by small drops deposited at random. The membranous productions of the capsule of the tooth withdraw to the top and sides, in proportion as the Cortical which they deposit on the enamel fill all the space which had remained between the different plates of the tooth. The summits of these plates are covered with enamel like the rest, so long as they remain unused. the same and sole production often deposits cortical upon the summit of the plate while it deposits only enamel at the base—It thus happens that the top of the interval of the plate is already filled with the Cortical at the same time that the base is separate (separè) Then the base of the capsular production finds itself separated from the top and receives no longer its nourishment but by its lateral attachments with the capsule—

The Deposition of the enamel commences almost with the transudation of the osseous substance and that of the cortical follows near, in such a manner that the summit of each plate is terminated in these 3 substances as well as its base (bien avant sa base) and that the adjoining plates are consolidated together by their summits before they are yet hardened at their bases.

These different operations do not go on at the same time in all the parts of the tooth, but they take place much sooner before than behind. One may imagine that the anterior plates will be readily united with each other by their summits and also by their bases, when the intermediate plates will be yet separated one from the other at least by their bases and where the posterior shall not have yet been formed and will only present but pointed and distinct (cornets), which are to become the summits of the plates.

From what we said it follows that the substances which compose the tooth are formed by Excretion and by beds (layers).

That the internal substance in particular has nothing in common with ordinary bones except its chemical nature—consisting equally of animal gelatine and Phosphate of lime, but resemble each other neither in their (tissue) nor in the manner of depositing nor by that of increase—Their tissue presents neither cellulosity nor Fibres, but only plates {fitted} {ingrafted} (emboitees) one in the other

When all the parts of the tooth are formed and consolidated—and that it begins to shoot from the gum—it experiences new changes—As the Elep^t is herbivorous, its teeth wear by mastication like those of all animals subject to the same law

(regime) It is necessary for their teeth to wear down, to fit the surface for grinding veget^a substance—The summits of the small indentures (ridges) of the plates wear first, once used to the interior substance each of the summits will present a circular or oval disk of this substance, surrounded by a ring of enamel and a ring of cortical—and there will be a range of these little circles along each plate.

- [4] If the Detrition penetrates to the bottom of the Slopes which produce the indentures, all the little rings will unite into one band of osseous substance, encircled by a double line of enamel and the cortical surface will make the round of the table of the tooth and occupy all the intervals of the bands—Each band will be the coupe of one of the transversal plates which compose the tooth—and if the detrition should extend to the place where the plates unite in one base—the entire tooth will then present only a large disk of osseous substance, surrounded on every side with a small border of enamel and another of Cortical—but the detrition can scarce ever go so deep, but it does not act at once upon the whole crown so that the consolidation does not take place.

The tooth by its Rhomboidal form in a vertical direction and by its very oblique position, presents much more of its anterior part to mastica[tion] than its posterior part. The plane or table produced by mastication, makes consequently, with the common surface of the summits of all the plates, an open angle behind—and it thence follows that when the plates in front are cut deep and form entire bands, the intermediate plates only yet present transverse lines or rings—and those behind are altogether untouched and present the summits of their dentelures in the form of rounded knobs (mamelons)—

The anterior plates are even destroyed before the posterior ones are brought forward, and thence arises another Phenomenon peculiar to the Elep^t. viz. that its teeth diminish in length at the same time that they diminish in height.

While the exterior part of the tooth wears down and decreases, the portion of the root which corresponds to it diminishes in an unaccountable manner. On examining it one finds it as if corroded—it presents irregular holes as if it had been subjected to an acid, which deposited on it in drops operated by a somewhat similar decay to what human teeth experience when stripped of the enamel—The tooth is deprived thereby in the different portions of its length of the segments or edges which occupied all its elevation.

Thence results also another singular effect, it is, that the

anterior part of the jaw, going on filling, the tooth moves from behind forward in a horizontal direction, at the same time that it proceeds in a vertical direction from above downwards, or from below to above according as it may belong to the upper or lower jaw.

Behold how it happens that each tooth no matter how large before, at the moment of its falling out, dwindles to nothing.

This movement of the active tooth makes room for that which forms in the back part of the jaw, and which is to succeed it. This second tooth helps by its development to push the first forward—and one might say that the {teeth of replacement} {remove of teeth} of the Elephant come behind the milk teeth, instead of coming from above or below as is the case in other animals—

Number of Teeth

[5]

The Royal Society first perceived the number in 1715 that the number varied from one to two on each side and that the place of division varies also. Pallas was the first to teach the mode of their succession by showing that at first they have one sole tooth on each side—That the second in developing pushes forward the first, so that for a certain time there are two—afterwards the fall of the first leaves only one in the jaw—

This succession or change of teeth takes place more than once, as I have found separate germs in an Elep^t which had already two teeth in place.

M. Corse (in the Phil. Trans. Tome 29. N^o 349, p. 370) has informed us that this remove extends even to eight times in the Indian Elep^t and that consequently 32 teeth successively occupy the jaw—

The first appear eight or ten days after birth, are well formed in six weeks and completely developed (sorties) in three months.

The 2^d are completely out in two years—

The third appear at this period and cast out the second set at the sixth year, and they in their turn are supplanted by a fourth series at the ninth year. We are not so well acquainted with the progress after—

In the first Elephants which Cuvier dissected and in five heads which he examined he constantly found three teeth at a time—viz. a little molar more or less ready to fall out—a large one in place in full action—and a germ more or less large more or less consolidated occupying the whole back space

of the jaw—but in the last Elep. which was about forty years old, there were only two teeth—the second of which, which scarcely yet began to shoot from the gum, filled all the posterior part.

One may judge precisely, by the depth of detrition, if a tooth which he finds single (*isolé*) was situated before or behind in the jaw—those of the fore part have not left one of their plates entire.

The number of plates which compose the tooth go on increasing in such a way that the succeeding tooth has more than the preceding one—

Mr Corse, who first made this remark, gives the numbers as he observed them—

The first have *four* plates only—

The second—eight or nine—

The third, a dozen or 13—

and so on to the 7th or eighth which have twenty two or twenty three—but M. Corse never saw teeth with more. We have reason to believe that these numbers are not so certain, for we have an under jaw, the first tooth of which has 14 plates and the succeeding 14 germs of plates—and M. Camper, has another exactly like.

Independent of the number there are differences arising from the thickness of the plates—They are more slender in the first teeth than in the last—and as the jaws are shorter when they carry the first teeth—it happens that the number of plates in use is nearly the same at all times, that is about ten or a dozen. When the Elep is full grown, the space occupied by the plates in activity is certainly, greater, but these plates are at the same thicker, and always fill the space whatever it be—

- [6] As it must take about the same time to use the same number of plates, the last teeth, which have most, last longer than the first—The removes therefore take place at more distant periods, as the Elep^t. advances in years—

The teeth of the Elep like those of all other animals do not strike their roots until the body is perfect. The root forms in layers like the rest of the tooth—

(Cuvier attributes the decay of the roots to the absence of ivory—)

The teeth of the two jaws of the Elep. may be easily distinguished by their form. Those of the *upper* jaw have their plates disposed in such a manner that their summits are all in a convex surface—

The table produced by their detrition is also convex

It is the contrary in these both respects in those of the Lower jaw—

A still more striking characteristic is the direction of the plates in relation to the crown or triturating surface—

Those under are inclined backwards, that is—the sharp angle they form with the plane of trituration is directed forwards—Those above on the contrary are inclined forwards, or the sharp angle which they form with the plane of trituration is directed behind—

It is always easy to distinguish the back of a tooth from the front—The grinding acting more on the anterior than the posterior—the point most worn of the crown is always the anterior—

We must remark in the mean time that the inclination of the plates on the crown diminishes in the two jaws, in proportion as detrition increases—The posterior plates which wear slowly, are rapidly brought into play, because their development towards the root continuing when that of the anterior plates has ceased—they are pushed upwards with more force—whence it is, that the table of detrition becomes more and more perpendicular to the direction of the plates—(à la direction des plates)

One can distinguish also the teeth belonging to either side—as they are convex at their internal face and a little concave at their external.

Comparison between Indian and African Elephants— [7]

The Plates of the African are not furrowed down their length as the In^a. but there is in the former a sort of fold in the centre which gives the lozenge shape to the tooth—

Besides the plates of the African are much thicker—10 or 12 will occupy as much space as 15 of the Indian—a less number therefore constitutes the tooth—The 2 species observe the same proportion in the teeth of the same age as in those of the same length, 4 or 5 being in the African, while there are 9 or ten in the Indian—

Also we have never seen an African tooth with more than 10 plates while those of the Indian have, according to Mr Corse 23—and we have seen fossil ones with 24 and 25 plates—

The male Elephant in general has tusks—The female has them also, but much shorter and often concealed under the lips—Some Tusks (the African are invariably the largest and whitest) weigh near 350 [? lbs]—the average is under a 100—

Ivory in the Indian and African does not differ, tho it

differs from the ivory of all other animals in its striated grain. The morse's seems to be formed of spots or particles consolidated together.

The tusks are irregular in shape, arising in some cases from variety of species, in others from accidental causes—curved or straight, spiral, vertical, downwards and even in Italy assuming the shape of the Italian S—

Diseases in the Ivory arise from some imperfection in the pulpy matter—as the tusk is formed it is pushed forward and added to, but not afterwards increased or diminished or affected when once formed—

The length of the Tusk is no rule for its weight, as the concave base may be hollow—The pulpy matter lies in it like a sword in a scabbard, but apparently totally detached from the trunk it has secreted—

[8] *Difference of the head—*

In the African species rounded—In the Indian, rising in the form of a double pyramid—this summit corresponds to the occipital arcade in man and other animals.

In the Indian Elep. the ears are of moderate size—in the African they are enormous and cover the entire shoulder

Average height of the Indian Elep in a state of slavery, from 9 to 10 feet—One in the Academy of Petersburg 16 feet $\frac{1}{2}$ given to Peter the G. by the king of Persia

Though the ancients considered the African as inferior in size, it is now ascertained that they attain the same growth and bulk—Perhaps they judged by the tame animals used in the armies of Egypt and Cartage.

[9] *On the localities of the living Elep.*

The species called Indian, inhabits all that tract of India on this side of the Ganges, for it was from thence or Ceylon that all the Individuals brought to Europe—There is no reason to doubt that it is the same species which inhabits ulterior India and which people the forests of Siam, of the Burman empire and Cochin China—

The species which is known as African is found in Senegal, from which place came that skeleton made by Louis XIV—and in the Cape of Good Hope. It is reasonable to believe it is the same occupies the intermediate country far west of Africa—

[10] *Fossil Eleph.*

As to the objection that they were brought by man where they are found—as long as it is confined to Italy and countries

much frequented by the Macedonians—Romans and Carthagin^a—one may think he finds a sufficient explanation in the prodigious quantity of Elep. which these people possessed—From various historical records it is clear that numbers of Elep^{ta} lived and even propagated in Italy—some of those found may have been of that number—but the circumstances under which they are commonly found, that a very small number indeed could proceed from that source—almost always they are found mingled with the remains of Rhin and Hippot, which certainly were not brought by annibal or the Rom armies—Before the discovery of those bones in other parts it was but natural that people would have recourse to the march of annibal—and accordingly the learned Dane Stenon resorts to this key, but annibal brought only 37 Elep. into Italy and Polybius tells that the cold killed them all after the battle of Trebbia, except one—Titus Livius who is more circumstantial left him still eight, 7 of which died shortly after from the fruitless attempt he made to pass the Appennines in winter—but both authors are agreed that in the spring when annibal descended into the marsh of the lower Arno—he had but one Elept. upon which this great general was mounted during that laborious journey when he lost an eye by a fluxion†—This one solitary Elept. could not surely have furnished the incalculable number of bones which are scattered through Tuscany and moreover there is an equal quantity of those of Rhin and Hipp. heaped confusedly together in the same beds which certainly were not introduced by annibal or employed in war—

It is very singular that they should swarm in countries which they do not now inhabit, and which they could not now support while there is scarcely any found in the latitudes they at present live in.

Wolf—

[13]†

After the most careful examination Cuvier confesses that so great is the similarity between the Wolf and mastiff that it is almost impossible to specify a precise difference—all he could observe was that wolves had the triangular part of the front behind the orbits a little narrow and flat—the sagitto-occipital crest longer and turned up and the teeth, especially the canines, thicker in proportion—but these are but light shades, which are often stonger [in] individuals of the same species—and one is tempted to think with Daubenton that

† [Livy. Book xxii., c. 3, page 768. Bohn's Ed. W.P.]

‡ [Pages 11 and 12 are blank. W.P.]

the Dog and Wolf are of the same species—if the analogy of other fossil animals did not authorize us to believe, that the Wolf has also its specific differences [?] but on the other hand if these differences are not sufficiently established, so neither is the identity of species with the recent by this resemblance of some parts. It is worthy of remark that this wolfs bones whatever they be are in the same state as those of the Hy, Tiger and Bear, the same color, the same consistence, the same envelope, all announce (proclaim,) that they date from the same epoch, and that they were interred together—

Bones have been found in Gaylenreuth, but not numerous—Kirkdale cavern produced a few teeth, but those figured in the Reliquiæ Diluv. P. 24—fig 15. 18, belong to young Hyænas—They were found also at Oreston, near Plymouth.—

Fox

found in the same tufa with those of Bear and Hy. if they are whiter tis because being small, the causes which could deprive them of their animal matter had acted upon them with greater force—in truth the stalactite which is now increasing in these caverns and which covers little by little the bottom in which they are {enclosed} {enveloped} might have encrusted recent bones at the same time that it encrusted anciently deposited bones, whence would follow what has been observed of the osseous breccia at Nice where recent bones fallen from above through the fissures would end in being enveloped in stalagmite—Cuvier remarks that he extracted himself from a mass a few inches in diameter, those bones of Fox he figures and observes if they had not been more generally found it was because that those who dig are struck only with the large, to the neglect of the small, which nevertheless, are not less curious, nor less important for the solution of the grand problem of fossil bones in general—

[14]

Cat

a species as large as a Putois (Polecat) found in Galynereuth [? Gaylenreuth]—only a few Phalanges—

Weasel

2 teeth found By Buckland at Kirkdale.†

Glutton

Glutton—an almost perfect head found by M. Scemmering at Gaylenreuth—an under jaw by M. Goldfuss—it resembles

[† Reliq. Dil. p. 18. W. P.]

the Glutton of the north and to such astonishing degree, and much more, for example than Bears, Hy^a—and Tigers resemble their congeners

This naturalist has recently obtained a head from the same place, and a third from the cavern of Sundwick, the same that is so rich in bones of Bears—We only know one species of Glutton confined in the forests of the north of Europe and of Asia, it does not appear to have descended towards the countries described by the ancients, for they do not speak of anything that resembled it—It is in Norway, in Sweden, in the forests of northern Russia near the white sea and in the most desert parts or Siberia that this species namely that of Swede[n] and Russia is known, the *ursus Gulo* of L. The wolverenne of Edwards, or Glutton of Canada scarcely differs from it—

Deer

[16]

We have found in Diluvium six species of deer one of which at least, the stag with gigantic horns has entirely disappeared from the actual surface of the Globe—

The osseous breccia offers us four others, of which three no longer exist at least in our climates and cannot be compared but to stags of very remote countries—

The regular rocky beds, the receptacles of the most ancient *Pachy^a* have furnished only one species of stag; that of Orleans, and it is entirely unknown at this day, even presents characters almost generic—

Thus the distribution of the genus in the different formations comes under the same rules as that of the *Pachy^a*—one may make an important observation on this subject—it is that if the fossil Rein deer was of the species now living or of a species with the same habits, its coexistence with the *Rhin^a* in the caverns of Breugues, and with the mastodon, near Etampes, will prove more and more what we have attempted to make manifest in our two first volumes—that the species of the great *Pach*, whose bones we find in Diluvium, dwelled in cold or temperate climates and lived in the very places where their bones are found interred without these places having undergone any great change in their temperature—

A similar remark might be made on the remains of the *Bos* which accompany those of *Eleph^a*—we have seen that one resembled the auroch, another the domestic ox, and if it be true that they proceeded from these species, which is not at all proved, at least for the first—they will come from animals

indigenous to cold countries and one would naturally come to the same conclusion respecting the fossil Elep^t

The osseous breccia appears now under quite a new view—The number of species manifestly quite unknown, and of [16] species at least strangers which they enclose is much increased—independently of the two Lagomys, we see deer of singular species, Tigers or Lions, Panthers, and what is still more remarkable is that the animals most like those whose remains they envelope—those to which one is tempted to refer these remains, are of animals inhabiting opposite climates, of Deer, and Tigers of warm climates, of the Lagomys of cold countries—It is rapprochement quite parallel to that of the {Di.} {Superficial} formations—

These unknown species carry the date of a great part of these breccias far beyond the epoch they are supposed to be formed—and lead us to regard them as contemporaneous at least with the beds which contain the bones of Elep^t Rh. Hip.—

Inductions

The Caverns with their bones proclaim a like antiquity—Among the numerous Carnassiers which fill them, there is one of the Hy, which is found associated, at Kirkdale, at Fourent, near Canstadt and Eichstadt, with Elp, Rh a narines cloisonnés, with Hip—in a word with the Pachy of the newest formations, and as the same species accompanies at Gaylenreuth Tigers and grand Bears it makes us refer these last animals as high a period as itself.

This Hy as well as these Tigers belong like the Elep and the Rhin to genera now confined to warm climates and yet it is associated in Caverns, not only with Bear, a race spread over every country, but with the Glutton, an animal whose only known species dwells exclusively in the frigid zone—

The Glutton, Hy. the Rein Deer, and Rh in the same [17] caverns, as we see them at Brengues and Gaylenreuth. The aurochs and Elep in the same beds, as they are found in the vale of Arno, reveal certainly a state of the earth very different from that which we now behold—or suppose in these animals a temperament strongly opposed to that which the species voisines [?] exhibit at this day—

This part of our work shows that {Carnassiers} {Carnivoreæ} existed at different periods of the ancient world in a proportion little differing from that they {have} {hold} now—and that their habits or mode of life was nearly the same.

In the Caverns the Carnassiers approach still nearer to the

subsisting races—not only are they all of known genera but if the great Bears, the great Tiger or Lion, the Hyæna are manifestly extinct species, there are, such as Wolf and Fox, some which we cannot distinguish from the living species by their osteology.

Enumerating the rocky beds, superficial beds, and Caverns and breccias, there occur 38 carnassiers in them—namely the 2 canis of Montmartre—the Wolf and Fox of the Caves—The grand Carnivore of M. Martre, the Civette and genetie of the same place—3 Bears of the Caverns, one of Diluvium, Hyt of the Caverns—their 2 Felis—which are perhaps different from those of the Breccias—Le Putois (Cat) and Weasel of the Caverns—La sarigue of M. Martre—to which we might add the Musaraigne of the Breccias of Cagliari—

I have made in the ancient and in the authors of the middle ages all proper research to ascertain if any of these animals had lived in our climate since the Historic times—and we can say that with the exception of the Aurochs or Bison which once lived more to the Ouest than at present, of the Lion which at the time of the Greeks had infested Macedon—of the Glutton which had sometimes wandered into Germany even in our time—and of the Urus or common ox, which appears to have been found in a savage state in Germany and even in France so low as the time of the Mérovingian Kings, I have [18] not discovered any positive evidence which could countenance these changes of habitation—

Cuvier persists in referring the destruction of singular species of which we discover the remains in a fossil state to an epoch anterior to the establishment of man upon the soil which covers them—

A very remarkable fact and one which goes to prove that it is not the animal Population of the torrid zone of the present day which we find thus in our beds and Caverns—is that in this assemblage of great and small bones, we have not found a relic of any quadrumana—Among the Lions, Tigers, Rhin, Elep there is never a monkey—it is not at all their smallness which prevents their discovery as even rats and musaraignes have been found—How has it happened for example that those of Kirkdale which have dragged to their den the carcasses and limbs of the largest Quadrupeds as well as the small, had never carried in neither a monkey, nor a maki, if it was not that none lived in their neighbourhood

This absence of Quadrumanania among the fossils causes us to treat no more of the bones terrestrial mammifera but of Rongeurs and Edentes—

[19]

Distinction between Irish Elk and Cavern

The Irish Elk has only one brow antler

Kents Cavern deer shew one in the same position and another springs immediately above it—

The under antler looks downward as if it fell over the eye—from the direction of the upper it would seem to shoot upwards—from the root of it the beam diminishes and gently tapers for about two inches at which point the horn separates, as if the remaining horn was only inserted in it—and exhibits some indented appearance at its broken edges in a doz specimens in my possession as in figure 3 (Horns)†

From the coronary circle to the superior part of the second antler the horn is compressed—then the beam becomes rather round and tapering—The Irish *Cervus megaceros* is round the whole length of the beam—of which there are two analogues from Kents Cave one in my collection, another in Mrs C * *—and perhaps a third in G. Society.

There is also a still greater number which broke off immediately above the brow antler and presents the same appearance of a natural separation as those which broke off above the sur antler—vid the large stump (not yet drawn, and numerous others of various sizes—

Besides the above I possess two middle sized horns rather injured—they are exceedingly flattened above the brow antler and dilated—it is not accidental as that part is injured—and this peculiar character occurs in both The surface of both is smooth more like that of bone than of ordinary horn—

[20] Between the round and slender horn figured 1†—and the large one fig 3‡—there were found all the various intermediate gradations—some miniatures of fig 3—others larger specimens of fig 1—of the former there were found about a doz—of the latter still more

I cannot help thinking that of the latter there is a variety at least, if not a distinct species—

It departs from the rounded form—and at the side that gives out the antler, assumes a sharp edge—from its base to the superior part of the antler—There is no appearance of a brow antler, but in its place a strong sharp projection flattened at its side—and about 3 inches from the base the antler shot off—

The largest of these specimens is deeply indented with transverse gnawing thro its whole length—by some hungry *

† [Probably Plate H, "Cavern Researches." W.P.]

‡ [Plate H, "Cavern Researches." W.P.]

* * as indeed are all the horns to a certain degree—Vid the Elks—

Animals of this Genus (Edin Ency) abound in England, Ireland, the Isle of Man, Germany, Sweden, France, Italy, Dalmatia, Gibraltar—most of them resemble some or other of existing species, but it is by no means certain that any of them does actually belong to these unless it be the Stag and the Roe. It is certain at any rate that these species occur in different kinds of alluvia; different at least in their antiquity and origin, if not in their appearance—Red Deer, or a species very much resembling it occurs in this Island in Ireland, and different parts of Europe, thus it has been found in the Valley of Somme in France. In England their horns occur in Lancashire, Yorkshire, Derby*, Northampton* Oxford* Lincolnshire, and most particularly of all near Norwich and Harwich. In the latter place they are associated with the bones of the Elep. R. and Hip. and if their approximation is correctly stated, were contemporary animals. They also occur in Peat, which being the most superficial of alluvias throws a doubt on their great antiquity.

The size of the red deer in former times were often superior to any that are now found—and their horns were rougher and thicker and bore more branches the consequence of greater age, more food and less disturbance.

Deer—Teeth

[21]

The last tooth in the under jaw of all ruminants is formed of 3 demi cylinders one after the other—the two anterior, while they are in germ have at their crown two saillant collines in form of crescents, whose convexity is turned out—by use these crescents enlarge and display their ivory bordered with enamel—the third demi cylinder presents only one crescent—there are then 5 crescents in this last tooth—

The two teeth which precede the last have only two demi cylinders—each has two crescents—there are therefore four crescents placed two and two—Such are the posterior molars which come only once and never change—But the 3 which precede them in the series change as in other animals. They have then first this form of milk molars and afterwards molars of remove—as to the molars of replacement which the animal carries the greater part of its life—

The third or that which immediately precedes the first posterior molar is also formed of 2 demi cylinders and of four crescents, but the posterior cylinder is smaller than the other and its crescents mix very soon.

In the second, the posterior cylinder reduces itself to a small saillant ridge—The first is simply compressed with two furrows at its internal face—

As to the milk molars, their difference from the removes is, as is common, in their greater complication—the third of the milk is formed of 3 demi cylinders and of 3 double crescents, consequently it is more complicated than the third hind molar—

The second has 2 simple crescents and 3 transverse prominences towards the interior—the first has 2 simple crescents and only transversal line—These animals take their first posterior molars before the fall of their molars of milk (see my Anstis specimen)† consequently as long as they have only five, it is the third which is formed of 3 double cylinders, but when they have six, it is the sixth which is in this case, because while this sixth was pushing out—the third milk tooth was replaced—

The 3 superior posterior molars of Ruminants appear to be the under retournés, they have the same forms of the two demi cylinders presenting each a double crescent—but whose convexity looks inwards—they are also much larger transversely. The last like the others, has only two demi cylinders, and 3, as the under one. The 3 molars of replacement or the anteriors of the adult animal have each only one demi cylinder and only one pair of crescents—and the first of all is irregular—but the milk molars always true to the law of greater complication, have all 3—like the posterior molars, cylinders and pairs of double crescents—and as they do not fall out till [22] when the animal has 5 superior molars like them among themselves—

The incisors as well milk as change, are 8 in number in all kinds except the camel—they have not the double edge which distinguishes those of the Horse, but are simple edged en biseau—They wear first in the edge and afterwards upon all the posterior and oblique face of biseau even to the root—

The changing Teeth are larger than those they replace, but in proportions which vary—The pair of the middle in the milk teeth is much larger than the 3 external pairs, especially at their edge—and the external ones are narrow and more or less oblique—The lateral incisors are narrow and arched outwards—

But the Elk is an exception to this rule—in it and the ox

† [Probably specimen from the Cavern at Ansty's Cove, about a quarter of a mile from Kent's Cavern. W. P.]

and sheep an inequality but slight in the milk teeth is very little marked in those of change

The camel has as well above as below its first molar detached from the others before—and which by its isolated position—and pointed form assumes the appear[ance] of a Canine—

They have rather in the upper jaw a real canine implanted at the anterior edge of the maxillary bone and which becomes with age as strong as the Canine of a great Carnassier. In fine they have a true superior incisor fixed in the maxillary bone and which takes the form of a Canine, it is thus that in the upper jaw they appear to have 3 Canines on each side—

As to the under jaw they have only 8 common incisors, but besides that the fore detached molar acts as a canine, the more external incisor takes a pointed form, and raises itself to s'engrener between the canine and upper incisor—it represents then encore a canine—and even in the old animal it has many appearances of a strong canine of a Carnassier—

The Elk differs from other Deer principally by the excessive shortness of the bone of the nose and the length of the intermaxillaries and the Rein D. by the smallness of the void spaces before the Lacrymaux.

Bears

[23]

Are of rare occurrence in alluvial strata—The remains of Bear in Kirkdale of very rare occurrence

We see at the epoch of the Anci[ent] Pop[ulation] which we are now passing under review the class of carnivora was numerous and powerful It reckoned 3 Bears with round Canine teeth—one with compressed canines—a Large tiger or Lion or Jaguar—another feline of the size of a Panther—Hy, Wolf, Fox—Glutton, Marten or Polecat and Weasel.

The common fossil Bear in its incisors, Canines, and grand [24] molars is perfectly like our northern Bear—But their magnitude announces particular species—our largest recent teeth are less—are at most only equal to the smallest of the fossil, and generally a fourth less than the largest. This uniform superiority indicates a difference and superiority of species which the other parts have confirmed, but these other parts have taught us at the same time that which the teeth have not told, at least in so clear a manner, that there exist in the caverns remains of more than one species of Bear—

These Cavern teeth are in general less used and have better preserved their enamel and all their eminences than those of the living Bear which shews that the species from which they

proceeded were more exclusively carnivorous—among the fossil heads only the largest and oldest have their molars worn—But there exist differences more marked between the fossil heads and the living relative to the small molar placed immediately behind the canine—as well above as below and in the first of the molars in the {series} {row} of the upper jaw—

The small molar behind the canines is never wanting in the living Bear,—whatever their age—and up to the present it has not been observed in the fossil species of large size, neither young or old, in the *upper jaw*—I have examined eight or ten of the fossil heads of different ages without finding it.

It exists only in the heads of the inferior species lately described by M. Goldfuss, and of which we shall speak presently—as to the under jaw I am well persuaded that it is not always wanting, even in the great Bears, for altho it does not appear in more than twenty jaws, or half jaws, young and old which I have examined, I have still clearly found the root of it in one of the half under jaws of the Paris Collection—another half has al[so]† shewn evidently its alveole socket

Another difference regards the second small upper molar which [in]† our living Bears is placed immediately in front of the antepenul[timate]† and forms with it a continuous series—I have only twice foun[d an]† alveolus in the fragments of heads which I have o[ne of]† which comes from Gaylenreuth and the other from Sundwick but there appears no trace of it in any of the other fragments, [nor]† in the entire heads of the grand species which I have seen

- [26] These Bears had then commonly in a continuous series above but three grinders, and in all but thirty teeth, while our living Bears have generally 36 and sometimes 40—Since we sometimes find from time to time one or other of these small molar teeth, the specific character of our fossil Bears will rather consist in their losing them very early—than in that absence of them—

As to the fossil species, our business is to show if they belong to one or other of the Bear now known—or rather whether they differ from the whole, as the differences in the length of the small anterior molars would seem to indicate beforehand—

I have already said that there were at least two species Let us commence by the most numerous which are at the same time the best characterized—

† [Part of the page torn off here. W.P.]

Their principal character is in fact in the great swelling of the front from above the root of the nose and the two convex bones of this same front, while the Polar Bear has the front the flattest—The Black Bear, as well of Europe as of America approaches nearer than the other to the fossil by their cretes [?], but they differ still more than the others by the flatness of their front

To these differences and to those which the teeth furnish may be superadded that of size being one fourth larger than the largest Brown B of Europe and one third larger than the Great black B

There is a second species with heads less bombè which Cuvier calls after Blumenbach U. Arctoides, because it more resembles the Black B of Europe than the U. Bombè does. This difference does not result from age for the B. less bombè is older, and when perfect was larger than the bombè—which latter character is found even in young animals of the Bombè species—

3 [? 3rd] Species. Head still smaller and less differing [26] from the recent than the preceding—tho old, as its molars were used and its ridges well defined, it is only of the size of the youngest heads with bombè front, nor is it quite as long as our great Black Bears of Europe—Its profile very much resembles that of the Brown B—*particularly that variety of the Alps* and is only a little more depressed—Its front is plane in every side and joins the bones of the nose with a sensible concavity—a character this by which this head approaches those of the Black Bears of Europe much more than the Brown—

The under jaw has the coronoid apophyses a little larger and more elevated—the distances of the molars from the Canine a little longer and the inferior surface more straight than in the Brown Bear

The alveolus of the little tooth behind the Canines in both jaws may be observed and of the first of the molars in series in the upper jaw which is mostly in the other cavern bears—

After these data it is impossible not to see in this head the proof of a species of B differing from the grand preceding ones—Its resemblance with our Brown and Black might make it appear identical with them but it is precisely because it partakes to a certain degree their character that I consider it to differ from one and the other—only specimen found and that at the bottom of the cavern—

From this examination it follows that there is to the pre-

sent moment in our caverns but 3 forms of known adults—those of the great heads with fronts bombè—and those of the great heads with fronts less bombè and more flattened and this small one like the brown bear recently published by Mr. Goldfuss—The under jaws of Bear are seldom found united with them and it is by chance that they are—

The most common differ from the others by a much greater size of the coronoid apophysè

- [27] The bones of Bear sometimes occur in the Diluvium—Those which we have observed in Tuscany differ from those of the caverns and very much approach to the Brown B—We shall retain for the grand species with front bombè the name of *Ursus Spelæus* which M M Blumenbach and Rosenmuller have given it To those less bombè and more flattened—that of *U. arctoides*—to the small heads the term—*Ursus priscus* of Goldfuss—

As to those fragments found in Tuscany—*U. Etruscus*—since changed into *Cultrodens*—

Spelæus characterized by a more prominent forehead than the living Bear—†

† [The lower half of the page is missing. W. P.]

[END OF FASCICULUS F. with the exception of a very few lines on the Hyæna, page 28, and which are quite unimportant. W. P.]

[FASCICULUS G.]

GENERA AND SPECIES OF ANIMALS DISCOVERED IN
KENTS CAVE

[1]

Mammalia**Genera****Pachydermata**

- | | | |
|---|-------------------------|--|
| 1 | Elephant—Asiatic | { Two tusks, lost their cohesion
and separated into laminæ which
broke into lozenge-shaped frag-
ments— |
| 2 | { Rhinoceros—
Bicorn | { doubtful—no Incisors found—
otherwise corresponding to Cu-
viers plates of the four extinct
species— |
| 3 | Horse, | { possessing some characters in
common, but differing in others
from the modern |
| 4 | Ox, | { a large species, Auroch or Buf-
falo |

Ruminantia

- | | |
|---|--|
| 5 | { Elk Irish
Red Deer
Stag
Fallow Deer &c
Rein Deer |
|---|--|

Carniv[ora]

- | | |
|---|---|
| 6 | { 4 Sp. Bear, <i>Ursus Cultridens</i> —
<i>U. Spæleus</i> — <i>U. Arctoideus</i> ,—
<i>U. Priscus</i> . |
| 7 | <i>Hyæna stri†</i> |

Bear—

[3]†

Long known in Germany as the fossil unicorn whose bones were disinterred from the caverns and applied for their supposed medicinal and supernatural virtues—The search for their bones first brought to light the contents of the different

† [The lower half of the leaf is missing. W.P.]

† [Page 2 is occupied with an account of "Lunel Cave." W. P.]

caves and even by the learned in the 17th century they were described as the bones of Dragons the analogues of the living and flying dragons in Transylvania—others to Seals and Hyænas

The largest of the teeth of modern Bears are less—or at most only equal to the smallest of the fossil—and generally one fourth inferior to the largest—

This constant superiority announces a difference and a superiority of species which is borne out by the other parts—and those other parts declare what the teeth alone do not so decidedly that there are in the caverns more than one species.

The cavern teeth are in general less used and have better preserved their enamel and their eminences than those of the living Bears—which proves that the fossil lived more exclusively on flesh—Tis only those of the largest and aged are worn.

The existence [of the] anterior molar of the under jaw of the gigantic Bear is established by its presence in the specimen fig†—only the obliterated traces of it were known before and these but in 2 half jaws—and were wanting in twenty jaws.

1 Principal character is in the great elevation of the front above the root of the nose and the two convex bosses (protuberances) of this same front— Spelæus of M. M Blumenbach and Rosenmüller— The coronoidal process of one in my possession measures in a line from the top to the lowest edge of the jaw $7\frac{1}{2}$ in—and across from the articulating process to the posterior molar $6\frac{1}{2}$ —

2 There is a second species with less rounded and elevated forehead and possessing other peculiar characters—Arctoidens—but as large as the former—

3. a smaller species and less different from the living species than the preceding—resembling in its profile the brown Bear of the Alps—but in other respects approximates to the black Bear of Europe—and the circumstance of its partaking of the characters of both black and brown and American to a certain point—renders it necessary to assign it as distinct species—

Only one specimen and that under doubtful circumstances as to its antiquity of this species was found in Gaylenreuth, the property of M. De Sœmmering. It is remarkable for exhibiting a small molar seated at the base of the Canine—In three specimens in my collection I find this small molar—the jaws are about one third larger than a large alpine Bear in my possession. *Ursus Priscus*—

† [Fig. 2, Plate D, "Cavern Researches." W.P.]

4 and in *Mr Welland ursus Priscus* and in another specimen I find a small molar with a few lines nearly in front of the row of molars in a lower jaw in a line of a peculiarity in the fossil Bear which has not yet been noticed. this is the case in *Ursus Cultridens* in Tuscany—Hence it differs from the existing Bears and from the fossil too—and agrees with the black of America which has in its under jaw 2 small molars—but the first is below the line of the row—in ours it is on a line—Thus in this cavern are there two Bears and a pendant [?] of the *U. Cult.* peculiar to it differing in the possession of the two small molars from those hitherto.

Hyæna (Osteology)

[38]†

Allied to the spotted Hy of the Cape but differing from it in the form of its teeth and head—

There are two species, the spotted and striped—the first is always distinguished by the greater bulk of the muzzle in proportion, by the greater {swelling} {roundness} of the head at the sides. Its great carnassier is also an invariable characteristic—both the upper and lower—

In the striped Hy, at the internal face of the second lobe a saillant tubercle, sometimes pointed (it is wanting in the spotted) in which respect it differs nothing from that of the Tiger but by its heel behind the second lobe.

As to the carnassier in the upper jaw, its cutting edge at its three lobes which in the striped Hy are almost equal amongst them in their dimensions, d'avant en arriere—while in the spotted Hy. the posterior one is alone equal to the 2 others.

In young Hy which still retain their milk teeth the sagitto occipit ridge is not yet found, The lines which mark the temporal fosses are not yet joined—the occipital crest is a little saillant jutting so that their heads have not yet that pyramidal vertex which distinguishes the adult and makes them appear at first heads of Bear—Their milk are like the permanent but there is a false molar at least as well above as below—and all are more cutting, less thick, and much smaller—

It is the third upper and second under of the adult which appear not to be represented in the milk set.

The first and second under milk teeth are like the first and third of the adult—Except that they are more compressed and have their lobes more pointed.

† [Pages 4 to 37 inclusive are missing. W.P.]

(Under Jaw)

The under Jaw of the Hyæna has also its peculiar characters independent of the milk teeth with which it is furnished—They consist principally in their relative shortness—for they are shorter than even that of the Feline—and in the saillant angle of its inferior edge, which is more marked than in any other carnivorous animal]

The Canines may be distinguished—the upper by their external concave face—a little flat at their internal—by the two sharp edges which separate them, and the anterior of which bifurcates towards the root—The under one has its posterior ridge rentree towards the internal face—

The superior Incisors are large and pointed like small canines—The middle ones are little and en coins have 3 tubercles at their posterior face.

The inferior lateral Incisors have one petty lobe at their external edge—The following are compressed principally at their root, which turns rather in—The middle are small and simple—

The posterior molar of the under jaw has a stronger approach to the *Striped* by its tubercles or protuber than in any of the teeth I have seen fig in Buckland or Cuvier—The same may be observed of the 3 molar of the upper jaw, whose internal face is more deeply festooned and set with tubercles than the corresponding teeth whether fossil or modern that I have seen in either of the authors cited.†

Remark

Here also may be observed that singular association of animals, the species resembling which live at the present day in climates so widely separated from each other as the Cape—the country of the spotted Hy—and Lapland the country of our present Gluttons—and Siberia the habitat of the Rein Deer, as in France—

[39]

Feline—

In comparing the respective numbers of the several species together, the scarcity of bones of the feline is not a little remarkable—The total amounts only to one upper jaw—about half a doz Canines and about the same number of molars—3 of the molars of an inferior size Panther‡—under jaw of cat, a species about the size of a Putois (Polecat) found at Gaylenreuth. The number from Kirkdale still less,

† [This paragraph is, in the MS., written in pencil. W.P.]

‡ [In the MS. "Panther" is written in pencil. W.P.]

or rather none at all as the Canine figured in the Reliq. D. is doubted by Cuvier—next to the U. Cultridens the scarcest—

(Is the same remark applicable to the German caves?)

To what is this scarcity attributable—was the species less numerous in those times—or was the superiority of strength his shield against those formidable assailants of the forest before which so many less powerful fell—We should find his bones.†

Tho it is certain (observes Cuvier) that the Tigers or Lions were contemporaneous with the Bear and Hy with whose remains they are found mingled, it still appears that they were less numerous than the other species”—

Whatever the cause of the rarity of his remains—whether he fell in the course of nature or by violence, his bones we perceive escaped not the jaws of this common carrier of the dead who dragged them with those of the shrinking deer into this repository of the most opposite species.

Buffon says that the animals which are called Tiger in [39]‡ America differ altogether from that of the old world, so much so that he pronounces with confidence that the Lion the Tiger and even the Panther are no more to be found in America than the Elep, the Rhin, The Hipp (* * * *) the Giraffe and the Camel. All these species require a warm climate for the purpose of propagation and having never inhabited northern regions could not convey themselves into America (Buffon, difference between both Continents)§

Blumenbach says that the bones of the Lion or of some similar animal are found in Hanover, near Osterode in company with those of Hy and of Elep in a marly substance. Some remains of this Genus are found to resemble the Jaguar of South America more than any other living species—

(Cat)

A species as large as a Putois (Polecat) found in Gaylenreuth—but a few phalanges—

Feline—Osteology

[40]

The indenture on the Canine which distinguishes the Feline kind is more strongly expressed in some species than in others—The Lion, Tiger, Panther, Leopard, Melas and all the small species have it very marked but among the grand—the Cougars, Juagars, Guepards, it is almost effaced.

† [In the MS. this last sentence is written in pencil. W.P.]

‡ [There is a duplicate "Page 39." W.P.]

§ [Op. cit. p. 456. W.P.]

The principal character of the Lion consists in the line of the face as well as that of the Cranium and each straight—

A second character regarding the first, is the compressing and even concavity of the part of the frontal bone between Postorbital apophyses—

The Lioness has this part of the head more stout in proportion to that of the face, and both more short in proportion to their size—and it appears that this is the distinguishing feature of the Female—

The Tiger almost as large as the Lion has the line of the face and the head more serpentine—(winding) and the orbital interval bombè—at both sides—There are likewise differences among the males in the proportional length of the head—They depend more or less on the development of the occipital ridge—which itself is modified by age—The females have also these parts more short.

The Jaguar which is the third in size of the Feline kind has the head more short in proportion than the Tiger—The interval between the eyes is more elevated—more swelling. The Postorbital apophyses are more saillant, and the Cranium has behind them on both sides a slight convexity.

The head of the young black Panther brought with its skin from Brasil has all the characters of the yellow adult Jaguar, except the convexity behind the Postorbital apophyses. The Panther has all the line upon the head of a uniform and moderate convexity—but the interval between the eyes is flattened transversely—This form well characterized occurs in the Leopard—The head of the Guepard differs no less than his teeth from those of other Felines; it is the shortest and most plump of all, while at the same time it is larger in proportion.

There are two fossil species, the large one is named *Spelæa*—the small one *Antiqua*—both the large and the small are found in the caverns of Hungary—Scharlfels, Gaylenreuth, Aldenstein, Nice—

(The large and the small occur in Kent's Cave—Canines of each are figured†—nor is the inferior sized one from a young animal as it bears marks of age—)

It appears from the great head fig by M. Goldfuss and copied by Cuvier in the 4th tome of *Oss. F.* Plate 36. fig 6. and from the fragment fig by Esper, that they wanted the small anterior molar in the upper jaw— M Gold^a observes that it is the same with all the fragments of upper Jaws which he has seen. In consequence in his first work he conceived its absence was suffic^t to indicate a specific character,

† [Plate E, "Cavern Researches." W.P.]

which he imagined was common to this animal and the Lynx to which Daubenton also denies this tooth, and it is true that Cuvier has not found it in any of the Lynx of Europe nor of America nor in any of the Chat cerviers which he has examined—though it exists in the Chaus and in the Caracal—but Cuvier rather suspects that it tumbles out early in the Lynx, than that it is altogether wanting—

(Is it wanting in the jaw from Kent's Cave?)

The component bones about a fifth larger than their corresponding ones in the Lion—and were of the species *Spelæa*.

The Class of Glires

Lagomys

[43]†

Composed in general of weak and small species has been little observed by the Collectors of fossil species and in all cases when the remains of these animals have been found in the strata or deposits of which we speak—they also have presented unknown species. Such in particular is a species of *Lagomys* found in the osseous breccia of Corsica and Sardinia somewhat resembling the *Lagomys Alpinus* of the High mountains of Siberia; so true is it that it is not always in the Torrid zone only that we are to seek for the animals which resemble those of this period.

Comparison of Numbers between Kirkdale and Kent's Cave.

Mr Gibson collected 300 Tusks which belonged to 75 Hy§ [48]†

The total number of Hyænas	300
Tigers teeth 4 in. long.—only	2
Bear	1
Wolf . . Molar	1
Fox . . many teeth	
Horns, broken, shed by necrosis	
Eleph {teeth, broken, 3 in. longest diameter	
{young. No Tusk	10
Hippot. molares. Fragments of its Canine	
and Incisors	6
Rhin—large—from aged animals	50
Horse	2 or 3
Ox . . two species	
Deer . Three species	
Glutton	
Lagomys	

† [Pages 41 and 42 are missing. W.P.]

‡ [Page 44 contains miscellaneous memoranda, and pages 45–6–7 are missing. W.P.]

§ [This is the Kirkdale list. See Reliq. Dil. p. 17. Unfortunately the Kent's Cavern list was either not written or has been lost. W.P.]

- [49] Three fourths belong to a species of Bear now extinct a half or two thirds of the remaining fourth belongs to a species of Hy— equally unknown at the present day, a smaller number belong to the Tiger or Lion kind—to the Wolf and Dog genus—Lastly the most diminutive have belonged to various small Carnivora as the Fox, Polecat or species allied to them.

Scarcity of Elep in German Caves

Elep. R. Ho. Ox, or Aurochs and Tapirs are seldom found in the Caves of Germany—some are said to contain none whatever—and the only bones of Herbivora are the remains of Deer.

In this respect Kents C. and Kirkdale differ from them as they abound almost as much in bones of large and small Herbivora as in bones of Carnivora—embracing nearly all the Pachydermata of the Dil. formation—

No bones of marine Exuviae either in Germany or England—(Shells in Kent's Cave)

The bones of Carnivora so numerous in the caves are rare in great alluvial strata

The Hyæ alone has been seen in any quantity at Canstadt—near Aichstedt and in some other places.

Their association in a fossil state shows that they must have lived together in the same country and epoch. (Notes Jamieson)†

- [50] Review of the various Genera of Quadrupeds that successively occupied the face of the earth—Theory of Earth P. 280

Previous to the order of animals which existed at the time of the last inundation the occupants of the earth were also Quadrupeds whose Races have totally disappeared and are found even in a fossil state only in certain places—whence we may infer that they occupied only insulated portions of the earth bounded probably by ridges and defiles—These animals are the Palæotheria or Anaplotheria (Etymology?) hitherto only found in the Gypsum quarries round Paris—(Have not the Deer species appeared in lower beds?) The sea which submerged the land they occupied and themselves left large deposits which still constitute at the present day at no great depth the basis of our present plains—It had then retired anew and left immense surfaces to a new population,

† [Jameson's Notes on Kerr's Cuvier's "Theory of Earth." Note K. p. 266. W.P.]

who being destroyed in turn have left their bones on the superficial covering of the earth in all countries known—

The Pachydermata still predominate and these are of a gigantic stature, Elep, Rh and accompanied by innumerable horses and several large ruminantia—

Carnivorous animals of the size of the Lion, Tiger and Hy had desolated this new kingdom. In general its characters even in the extreme north and on the borders of the present frozen sea was similar to that which the torrid zone alone now presents—and yet there was no species in it absolutely the same as any of those which are found alive at the present day—

Mammoth—The most remarkable of these animals is the species of Elep named mammoth (Etymology?) by the russians (El. Primigenius of Blumenbach) which was fifteen or 18 feet high and was covered with coarse red wool along its back—Its enormous tusks were planted in alveolæ longer than those of the Elep of the prest day, but in other respects was precisely similar to the Ind. Elept.—It has left thousands of its carcasses from Spain to the shores of Siberia and it has been found in the whole of North America—shewing that it had been distributed on both sides the Atlantic if indeed that ocean had existed in its time in the bed which it occupies at present—

It is well known that its tusks are so well preserved in cold countries as to be applied to the same purposes as fresh ivory—Individuals of it have been found with their flesh, skin and hair, which had remained frozen since the last general catastrophe—

The Tartars and Chinese imagine it to be an animal which lives under ground and perishes at the sight of day—

Of 78 Quadrupeds in a fossil state Buffon [? Cuvier] says that 11 or 12 are now existing and that 16 or 18 are doubtful.†

Mastodon

Next mastodon, two species, great and small, armed with tusks like Elep, with teeth bristling with points which long furnished what is called occidental Turquoise, abundant in temperate parts of Europe—but not so much in the North—

The Great Mastodon is very common in N. America—

The Indians imagine it was destroyed by the Gods to prevent its destroying men—

Next Hippot^a abound in the countries which now form England France and Germany and closely resembled the

† [See Kerr's Cuvier's "Theory of Earth," § xxviii. p. 103. W.P.]

present African species—also a small ape not larger than a Wild Boar nothing similar at present known to exist—

[51] History of fossil Cavern bones

Before these last discoveries says Cuvier (P. 302—T. 4) and particularly that in Yorkshire there were known but those Caverns in Germany and Hungary which contained the remains of Carnivorous animals—

The discoveries alluded to are the Caverns of Kirkdale and the recently known cavern which extends more to the south of and is even on the side of the Alps facing Italy—It is that of Adelsberg in Carniola situated on the grand road of Laybach to Trieste and about the same distance between these cities—

The whole of this country is hollowed out with grottoes and caverns which have produced on the surface a great number of sinkings or chasms, which renders the face of the country very unequal—Many of these caverns have long been celebrated among naturalists—That[of] Adelsburg is generally visited by *Travellers* from its vicinity to the great road—

Inscriptions are legible so far back as 1393 to 1676. Human bones and skeletons are buried there—This suite of chambers had been unknown during the interval until the Chevalier de Louëngreif burst in upon it in 1816—

[52] Number [of Elephants' Teeth]

The Roy. So. first discovered in 1715 that it varied from one to two on each side.

Pallas was the first who showed their mode of occurrence, by remarking that at first they have only [one] tooth on each side—

That the second in advancing pushes forward the first, so that for a certain time there are two—The fall of the first leaves but one in the jaw

M. Corse (in the Phil Trans Tome 29—N° 349—P. 370) informs us that this process of succession goes on even to 8 times in the Ind Elep and that consequently 32 teeth may in succession occupy the jaw—

The first appears eight or ten days after birth, are well formed in 6 weeks and completely developed in 3 months (gone ? Sorties)

The second completely sorties in 2 years—

The third appear at this period and cast out the second set in the 6th year—

and they in their turn are supplanted by a fourth series in

the ninth year—beyond which the progress of remove is not well ascertained—

The number of Plates which comprize the tooth go on increasing in such a manner that the succeeding tooth has more than the preceding one—

Mr Corse who first observed this circumstance, gives the numbers as he observed them—

The first have 4 plates only

The 2 . . . eight or nine—

The 3 . . . a doz or 13—

—and so on to the 7 or eighth which have twenty two or three—but Mr Corse never saw teeth with more—

The removes take place at greater intervals as the animal advances in years.

Independent of the number there are differences arising from the thickness of the Plates—They are more slight in the first teeth than in the last—Ten or doz plates are generally in use—the average of those worn in the teeth discovered in Kents Cave—The teeth of the Elep—like those of all other animals do not strike their roots till after the body of the tooth is perfectly formed—

Comparison between the African and Indian—

[53]

The plates of the African are not so furrowed Down their length as the Indian, but there is in the former a sort of lapping in the centre which gives the lozenge shape to the tooth—

Besides, the plates of the African are much thicker 10 or 12 will occupy as much space as 15 of the Indian—a less number therefore goes to the tooth—both species observe the same proportion in the teeth of the same age—four of [? or] five in the African form as large a tooth as 9 or 10 in the Indian—

Further no African tooth is known to possess more than 10 plates while those of the Indian have according to M. Corse (and specimens in my own possession 23—and there are fossil ones with 23 or 25 (How many in Belfields?)—

The male Elep has tusks—so has the female, but much shorter and often concealed inside the lips—some tusks (the African are the largest and whitest) weigh near 350 lbs—the average is under a 100—

The ivory does not differ in the Indian and African—tho its striated grain distinguishes [it] from that of all other animals That of the Morse appears to be formed of spots or particles consolidated together.

The tusks are irregular in shape arising in some cases from variety of species in others from accidental causes, curved or straight, spiral or vertical, bending downwards and even twisted like the Italian S—

Diseases in the Ivory arise from some imperfection in the pulpy matter which fills the cavity of the tooth and drop by drop forms the ivory—as the tusk is formed it is pushed forward and added to, but not increased afterwards or diminished or affected when once formed—

The length of the tusk is no rule for its weight as the concave base may be hollow The pulpy matter fills it like a sword in a scabbard, apparently totally unconnected with the trunk it has secreted.

Difference in the heads of Af. and In

In the African it is rounded—in the Indian rises in the form of a double pyramid This summit corresponds to the occipital arcade in man and most other animals—

In the Indian Elep the ears are of a moderate size—In the African enormous, and hang down the whole length of the shoulder—

Average height of the Indian in a state of slavery from 9 to 10 [feet]—one in the academy of Petersburg 16½ ft given to Peter the great by the King of Persia—

Though the ancients considered the African as inferior in size it is now ascertained that they attain the same growth and bulk—They most probably judged by the tame animals used in the armies of Egypt and Carthage—

[62]† Hard and solid bones of the Tarsus and metatarsus generally escaped untouched—some specimens however have been so mutilated and eaten round as scarcely to retain a trace of their original form—Not even the bones of the astragalus the most smooth and unmanageable of all were altogether rejected, as they exhibit deep scratches and fining off at their edges, though they were too solid firm and flinty to be cracked and and devoured like the other bones—

† [Pages 54 to 60 inclusive are missing. Page 61 contains miscellaneous memoranda. W. P.]

[END OF FASCICULUS G.]

[According to its "Index" it extended from Page 1 to Page 60. W.P.]

[FASCICULUS H]†

THE course of the workings also laid open to view other [5] objects referrible to a very high antiquity illustrative of the barbarous habits of the primitive colonists of Great Britain or their descents [? descendants]. Human skeletons attended with ornaments and weapons fashioned of bone and flint and similar minerals, indicative of the modes of life of the {individuals} {nomad tribes} have been found lying across our path—Numerous fragments [of] sepulchral vases and urns crushed under the weight of fallen masses, with scattered deposit of ashes, arrow heads and calcined bones marking perhaps a different race accustomed to peculiar rites of interment denote the gradual advances of society to civilization—and next appear the vestiges of a more polished people in relics of armour and pottery of superior workmanship ascertaining the period of the Roman occupation of this district concurring with relations of history and tradition. To these records after a long interval succeed numerous inscriptions on the floor and sides legible to the commencement of the sixteenth century when the cave began to {draw} {attract} crowds of visitors as an object of curiosity—That the cave whose open {entrances} {portals} must have invited visitors, continued to be frequented from the Roman period down, there can be little doubt, the open entrances inviting the shepherd and hunter—but the record of these visits if committed to the walls have been overlaid by the advance of incrustation which already threatens later with a similar fate. The stripping away of the laminæ of the sides will doubtlessly reveal names and dates at present glazed over.

In the present advanced state of this popular branch of [6] science it is superfluous to dissert on the value of every new accession to the stores of the fossil kingdom and consequently to the materials of observation.

The science of comparative anatomy being {now} {henceforth} inseparably wedded to the laws of inductive reasoning by the demonstrations of their mutual tendencies by Baron

† [As this Fasciculus has neither pagination nor Index its original extent cannot be determined. Four pages at least appear to have been torn off; hence I have termed the first page of the remnant "Page 5." W. P.]

Cuvier, acquisitions to the one branch subserves the purposes of the other—each fresh fossil acquisition to the subjects of the anatomist each new document illustrative of the peculiar structure of the ancient animal population of the earth, elucidates lets in a new light on the changes that have passed over the Globe in which they participated.

It may suffice in this place to remark, for into the details the reader may not [be] disposed to enter, that after collating bone with bone of the fossil species with the recent, the conclusion to which the labors of the illustrious French naturalist conducted him after a survey of frequently imperfect and solitary specimens is completely supported by the display of the splendid disclosures of this repository which declare the existence in the fossil tribes of specific traits of organization that discriminate them from their modern congeners, and refer them over to a system of things that expired with them. These views have been enlarged by the generalizing mind of Dr. Buckland into important evidences founded on the legitimate inductions of science from the phenomena of caves and gravel in attestation of the truth of the sacred record. The coincidence of the signs of nature with dogmas of Faith, tho not sought by men whose belief rests on higher sanctions, is still too singular to be overlooked when it thus obtrudes itself on the eye—

Nature is heard to speak the same language as man (Cuvier)† and where she appears to dissent it is attributable to the wrong interpretation of her voice, such statements being no less at variance with physical evidence and well balanced inference than with the authority of the inspired writings.

- [7] How far these positions are sustained by the facts disclosed by the researches will appear in the sequel.

The most important condition required for expounding the problem of the history of caves had been frequently asserted by the first authority among continental Geolo^a to consist in a nice analysis and appreciation of all the circumstances which might disguise their real origin, it has been endeavoured tho at the hazard of repetition and prolixity to adhere to this rule in the account of the respective chambers

This caution is thus beautifully set forth by the great example of inductive science Lord Bacon.

“Men use commonly to take a prospect of Nature as from a high turret and to view her afar off and are too much taken up with generalities, whereas if they would resolve to descend and approach nearer, and more exactly and considerably look

† [See Kerr's Cuvier's "Theory of Earth," § xxxii., p 146. W.P.]

into things themselves, there might be made a more true and profitable discovery and comprehension."†

Geol. Description

[9]

The district in which the caverns forming the subject of the present memoir occur constitutes that portion of the S.E. coast of Devon the headlands or two horns of the crescent of Torbay—the S.E. limit of the coast of Devon—It is characterized by a great diversity of formation of which the principal is the carboniferous or mountain limestone—but so intermingled is this rock with other strata that it is not easy to convey a distinct idea of its * * *

The new Red conglomerate compounded of the spoils of pre-existing beds of the older Lime-and-sand-stones, Quartz, Shale, Killis and porphyry, identical with the Exeter pudding stone stretches away from the Ness of Teignmouth to Preston Sands on the west flank of Torbay, sweeping by and over the insulated mass of limestone at Petit Tor which appears encircled by a zone of this conglomerate, comprehending in its range, St Mary Church, Watcombe, Tormoham, and Paignton—This latter stratum reposes generally upon carboniferous limestone, the Transition of Con[tinental] Geol., and old red sandstone—The last which occupies an extensive area in this county and which is so well displayed at Cockington Sands seems to merge into a schistose and micaceous variety of grauwacke

The limestone which encloses the caverns is mineralogically identified with the rock at Oreston which furnished the materials for the Plymouth Breakwater—It likewise contains similar caverns and organic remains—It is commonly of a shining grey streaked with red, traversed by veins of carbonate of lime abounding in pink and white varieties of Barytes and in the vicinity of trap as at Blackhead assumes a semi-crystalline aspect and at Petit Tor, so impregnated is it with the oxyde of iron that it displays those exquisite tints which recommend it as an ornamental marble. Among its organic constituents may be distinguished Trilobites, Encrinites, Nautili, Orthocerae, producti and several testaceous [10] varieties of mullusca and corals which are worked up into trinkets. It projects in the promontory of Blackdown and forming into conical hills as that containing the cavern and Waldon hill—the western rampart of Torquay, after suffering intersection by a tongue of red sandstone at Tor

† [See the "Impetus Philosophici," Bacon's Works, Bohn's Ed. 1850, vol. ii. p. 680. W.P.]

Abbey reemerges at the opposite arm of the Bay at Goodrington Sands, where associating with trap it acquires the properties of serpentine and undergoes other modifications of its qualities that it refuses to effervesce with acids—From Gooding[ton] after pursuing a sinuous course it throws itself forward in the headland of Berryhead along which line it is interspersed with caverns—Thence it continues on to Plymouth. Throughout the district under consideration are visible the most decided evidences of disturbance—The cliffs from Blackhead to Berryhead on both sides the bay display every possible modification of disorder in their fissured and contorted outlines and dissevered masses marking their former affinity to land lie, at the base of the cliffs, in the sea—We must seek in the promontory of Blackhead the clue to the primary cause of this derangement and refer to subsequent action the changes superinduced upon it. There porphiritic trap protrudes upwards among the incumbent beds of shale insulating the dislocated strata, and the limestone in the superior region of the cape exhibits corresponding signs of displacement.

Mr de la Beche† whom I attended in his survey of this district is inclined to connect these with the dislocations in the Oolitic series, East of this quarter, referring them to [11] that supposed volc[anic] force which elevated the chalk strata in the Isle of Wight and even possibly that which threw up the main ridge of the Alps—and not improbably the same agency which elevated the mountain chain of Dartmoor, and threw up the conical hills studding the plains on all sides—depressed and submerged the interjacent plain between the arms of Torbay—and between England and France whose former relation has been geologically determined—

Mr de Luc in his *Geol Travels* was strongly impressed with this scene of disorder—Vol 2. “I could have fancied myself on certain summits of the *Jura* where the *limestone strata*, dipping internally, shew at the surface their sections, rising in separate masses above the grass. This is exactly the case here; the surface of the hill being studded with rocks, which are the points of the limestone strata whereof its mass is composed; so that, if the upper part of one of these summits of the *Jura* towards a valley could be taken off to the depth of five or six hundred feet, and set down by the sea-side, it would form a very accurate representation of this promontory” (of Blackhead). “There is,” continues he, “a

† [Trans. Geol. Soc. Lond. 2nd Series, vol. iii. part 1, p. 170, 1827. W.P.]

succession of caverns within this mass, the Jura contains many of the same kind."†

To this agent primarily then may be attributed the formation of the caverns, coombes and confluent vallies—the latter being rents or indentations originally laid open by the above causes which served as channels for the movement of the fluid were subsequently excavated and enlarged by the fluid which threw its suspended materials into the opposing cavities and caverns of this range—

The valley of rock thro which the New Teignmouth road winds with its corresponding escarpments of salient and reentering and the contraction of the basin towards the [12] bottom of the bed, excavated in the shape of waterworn basins favors this hypothesis.

And long before the existence of fossil bones were ascertained or the action of Diluvial causes advanced, Mr de Luc recognized the presence of sand on the hills as at Waldon‡ [Hill], which is clearly not the detritus of the marble—but a stratum superinduced upon it, whence from the burrowing of the animals in the sand it is called the Warren. In this sand I have detected the fragments of different strata—

Mr de Luc traced the red sand to the Dartmoor range at the base of the Botterrock, the substratum is Basalt and granite. "Hence," says Playfair vol i. 126, "fragments of rock, from the central chain, are found to have travelled into distant vallies, even where many inferior ridges intervene: hence the granite of Mont Blanc is seen in the plains of Lombardy, or on the sides of the Jura; and the ruins of the Carpathian mountains lie scattered over the shores of the Baltic."

The Cave

[13]

The entire body of the limestone, as has been remarked, is traversed by chasms or perforated by caverns—within an area of a few miles occur the group of Kent's Hole Anstis Cove, Barton and Berryhead besides innumerable minor cavities—The first and principle of these natural excavations is Kent's Hole or Cave, the words being synonymous in the Saxon. It stands N. E. of Torquay, removed at a short distance from the new Teignmouth road by Babbicombe—and is situated half way up the acclivity of the low ridge which forms the western flank of the vale of Ilsham detached masses stru its sloping sides and overhang its entrance which interspersed with wood

† ["Geological Travels." By J. A. De Luc, F.R.S. In three vols. "Travels in England." Translated from the French MS. London, 1811, vol. ii. § 799. W.P.]

‡ [Ibid. § 802. W.P.]

impart to it a highly picturesque effect heightened by the approach over an old and steep remains of a water course, and winding through a skreen of copsewood.

Two mouths separated by an interval of rock a dozen yards open directly in the face of the cliff

The South East entrance is formed by the bending of the rock into an arch, on the inside displays a bolder curve above which the leaves of the rock strata unfold successively in broader * * * * till they assume at the summit nearly a horizontal line.

The aperture on the right is at present the ordinary because the more accessible entrance— It is simply a cleft which may be seen enlarging towards the bottom and closes at the top of the rock. Till lately its dimensions obliged the party to file allowing no more than one person to enter at a time [14] and even so in a stooping posture.

The level of this entrance is raised many feet by the addition of modern rubbish and mould spread over another more ant^c bed, as a precaution against the entry of cattle—before which it was sufficiently capacious to admit an ox, but still less ample tho deeper than the other the rocky and slightly polished floor of which when cleared by Mr. Northmore in my presence presented space sufficient for the passage of 3 persons abreast—it admits directly into the body of the cave and throws a faint light round the edges or limits a few feet round, beyond the limits of which all is palpable darkness better answering to Senecas description of Polipo—"Nihil illis faucibus obscurius, quæ nobis præstant, non ut per tenebras videamus, sed ut ipsas"†—darkness that can be scarcely {penetrated} {dissipated} even by the glare of many torches.

The floor on the outside showed no vestige of the red deposit which is found inside, having most likely been washed away by rains—amongst the rubbish as was natural were descried only fragments of stalactites modern bones and other adventitious matters— The floor was rocky weather-worn, slightly polished—and as shall be afterwards seen suddenly sinks or slopes downward inside the arch to an * * * * depth

The covering of the floor of the S. E [? N. E.] entrance was pierced to the depth of six feet without reaching the rock, which was found more shallow at the other mouth.

† [Seneca's "Epistles." Epist. 57. W.P.]

[FASCICULUS I.]†

THE high antiquity which has been assigned to the instruments of flint gathered near the surface of the diluvium and the conclusions regarding the early colonization of this district which we have founded on this discovery derive support from the assertions of Holy writ which distinctly records the distribution of the fathers of the H[uman] race over the earth immediately after the deluge.

The same inference may be gleaned from the mass of * * * preserved to us in the mysteries, traditions rites and symbols of the aborigines of the most widely extended regions—all of which according to the least suspected authority bear manifest reference to an awful catastrophe, such as the deluge and the providential deliverance of the founders of these several nations from a fearful calamity—

Tho not possessing the precision of evidence, still it may be interesting to consider them as curious coincidences with the facts of revealed history which the researches of Celtic scholars have brought to light—but before we enter on this division of the subject we shall shortly revert to the statements of the early dispersion of the seeds of the H. race which is contained in the inspired volume.

After reciting the particulars of the deluge and the preservation of a just and favored family Moses proceeds to say “and from these” (the 3 sons of Noah) “was all mankind spread over the whole earth” Gen. c. 9, v. 19. † and further on c. x, v. 5. “By these (Japheths immediate offspring) were the isles of the Gentiles divided in their lands; every one after his tongue, after their families, in their nations.”

and the history of their generations and the distribution of the patriarchs and their families thro the globe is thus summed up c. x, v. 32, “These are the families of the sons of Noah, after their generations, in their nations: and by these were the nations divided in the earth after the flood”; and to mark this dispersion and the partition of the earth one of the sons of Heber was named Phaleg, “because in his days the [3]

† [This Fasciculus has neither pagination nor Index. No part of it, however, appears to be missing. To facilitate reference, I have paged the original, 1, 2, &c. W.P.]

‡ [Douay Bible. W.P.]

earth was divided"† or as it is elsewhere expressed—"The Most High divided to the nations their inheritance."‡

Thus early whilst yet the earth was hardly drained of its waters was their respective patrimony allotted—while yet their manners were simple and the soil supplied their humble wants—when luxury and its encumbrances opposed no obstacle to their migration—and the easy transportation of their children and cattle—while yet the beasts of the field had not so multiplied as to preoccupy the new regions or prevent their tranquil settlement—

And should it be objected that this primitive people had not yet acquired sufficient knowledge to enable them to pass over intervening rivers and seas in their passage to their destination—we should keep in mind that having lived with Noah or his immediate descendants, it was only natural for them to study those arts which would fit them for the purpose of colonization—During the long notice of the approaching visitation, Noah cultivated the arts of building and navigation and we may presume learned those particulars regarding the known scites of the country before the flood necessary to the founder of a new order of things. This knowledge would be cherished by his contemporaries and by them transmitted to the succeeding population of the world who would obviously apply it while bending their steps in quest of uncolonized isles and continents.

And the learned author of Celtic Res.[earches] in P. 104, takes this view of the rise of society—"In an age or two after the first partition, every region of the known world which was adapted to the support and comfort of human society must have viewed that germ which gradually expanded into its primitive nation and thus Spain and even Britain were probably colonized by those who were born within a century of the Deluge."

- [5] Societies thus planted and formed must have carried with them the primitive history, the primitive religion, institutes, customs, habits, opinions, the arts and sciences of the Patriarchal age and the primitive language with only those occasional variations and modifications which result from local causes. "And the earth was of one tongue and of the same speech." Gen. xi. v. 1. § Such was the condition of society before the discomfiture of Babel—On the knowledge derived from Noah from the antediluvian age which was skilled in

† [Gen. ch. x. v. 25. Douay Bible. W.P.]

‡ [Deut. ch. xxii. v. 8. W.P.]

§ [Douay Bible. W.P.]

the division of labor and the mechanic arts—in the conduct of pastoral and agricultural life—the use of iron and Brass—music, the impious confident Nimrod engrafted those improvements that are produced by sustained culture and experience, as was fatally displayed in their bold defiance of the work of God.

And if in the seats of early colonization we do not find traces of this advanced state of civilization, their absence may be explained by the breaking up of society and its dispersion and the poverty and destitution which must have thence followed. The hands that were lately employed in raising the Heaven daring tower, were now forced to seek uncertain food in distant lands. They were driven from among men and scattered into all lands. Their disorder is naturally succeeded by indigence and all the evils of savage life, and the degrading occupation of hunters of wild beasts and robbers. The effects of this dismemberment of society would be soon apparent in the degeneracy if not loss of the manual arts and the absence of the conveniences of society. Mechanism of all kinds, observes the author before quoted, depends much on external means, particularly the use of the harder metals—These were well known before the separation of mankind and there can be no doubt that the Noachitæ furnished themselves with those implements which they might have then (about to go into new countries?) have occasion for—But what the present family carried in their hands [7] would by no means supply the future nation—Some ages may have elapsed and the metallurgic mystery may have been forgotten, before they discovered veins of ore in their new settlement—Merchants from the central regions would not begin to traffic with strangers till they became sensible of some wants of their own, and then they would visit only such countries as were provided with commodities to reward their labor—Many remote nations then were compelled to resort to the arrow and spear head of flint or Bone for the field and the stone hatchet for a double purpose—military and domestic—for hewing of their wood, or for the havoc of their foes. What remains of metal they might still possess only glittered in the hands of their chiefs. (ibid 114)

From the total absence of every relic of metal in the Diluvi[um] and the great abundance of weapons of flint, we may conclude at least that they had not yet discovered its existence in Britain, if they were not entirely ignorant of its properties and its subserviency to the arts of life. A nomadic people strangers to even the rude pottery of a later period,

most probably were also strangers to the use existence and application of the hard metals, which in after ages their descendants learned from the enterprising people of Phenicia.

Perhaps the best delineation of these first colonists is found in Tacitus description of the Fenni (a people of Germany)—The savageness of this people is scarcely credible. their poverty—squalid—without arms—without horses, without a home—wild herbs constitute their food, the skins of beasts their clothing and the ground their bed—They trust for support to their arrows which for want of iron they point [9] with bone—The chase is the common occupation of the women and the men—The females accompany the men in their wanderings and claim their share of the booty—Their only expedient for defending their infants against the fury of beasts of prey and of the elements is interlacing by weaving round in the form of a cradle the boughs of the trees—this frail fabric serves as a shelter equally for the old and the young—and this savage mode of life they think preferable to laboring in the fields or the drudgery of building—and to those painful {vicissitudes} {solicitudes} of hope and fear which attend the acquisition and defence of property whether personal or belonging to the community—

"Fennis mira feritas, foeda paupertas: non arma, non equi, non Penates: victui herba, vestitui pelles, cubile humus: sola in sagittis spes, quas, inopia ferri, ossibus asperant. Idemque venatus viros pariter ac feminas alit. Passim enim comitantur, partemque prædæ petunt. Nec aliud infantibus ferarum imbriumque suffugium, quam ut in aliquo ramorum nexu contegantur: huc redeunt juvenes, hoc senum receptaculum. Sed beatius arbitrantur, quam ingemere agris in-laborare domibus, suas alienasque fortunas spe metuque versare."†

Or as Job in c 30. describes the father of a race his contemporaries and which is supposed to have reference to the exiles from Babel. "The scattered over the face of all the earth, who cut up mallows by the bushes and juniper roots for their meat—driven forth from among men to dwell in cliffs of the valleys, in caves of the earth, and in the rocks."‡

† [Tacitus, De Moribus Germaniæ, cap. xlii. W.P.]

‡ [Job xxx. 4, 5, 6. W.P.]

[END OF FASCICULUS I.]

[FASCICULUS J.]

[SCRAPS, NOTES AND MEMORANDA]

[129A]†

[1]

[Dedication]

To Sir Lawrence V. Palk, Bart.

The history of researches
 Conducted with his permission,
 on his estate
 Is gratefully
 inscribed
 by the
 Author

Tor Abbey—

[2]

[Dedication]

To Sir L V. Palk Bart M.P.

The following memoir of discoveries
 made in caverns
 situated on his estate
 is inscribed
 in testimony of the facilities afforded
 for their investigation
 by the Author.

[3]

Motto

A retrospect into the early periods and state of Britain—the character, the arts and the customs of its primitive inhab^{ts}, is not an exercise of idle and simply curocity; but of critical importance in the pursuit of Histo^l and Phil^l truth—It not only delights the imagination with a view of our hills, valleys

† [“129A” denotes that this scrap occurs on the 129th page, Fasciculus A., and so on in other cases. W.P.]

and plains as they presented them to the eye *3000 years ago* and shews to us the simple native in his first occupations; but also points out the origin progress and improvement of such knowledge as to this day constitutes the ornament and comfort of society." *Cel. Res.* 118

The Governments, the Institutions and customs of that nation were in great measure obliterated by the Romans who discovered but little curiosity either to examine the history of strangers whom they despised or to enter minutely into the value of establishments which had been doomed by their decree to ruin. (Hence we find them breaking into their tumuli) consequently the notices which they have left us respecting the Celts are slight and superficial, from them however it may be collected "that the Celtæ were possessed of some useful knowledge not common to them—with neighbours more polished and which deserved a better fate than total oblivion." *Vid the {history} {compendious and interesting summary} of their manners, laws, functions.* P. 118–119.

[4]

[62o]

Preface

In tracing the history of my discoveries in the caves which form the subject of this notice it appears desirable to place before the Readers eye a condensed view of those of a similar kind made in different parts of the world—in order to {demonstrate} {exhibit} the striking analogy displayed in their relations to each other in their respective species, and in the vicissitudes which have affected them—A General sketch therefore, of the nature, locality and number of Land animals known in a fossil state will be found prefixed, under their respective heads to the particular description of their corresponding species in Kent's Cave, and such anatomical characters noted, according to the acknowledged laws laid down by Cuvier as may show the propriety of separating the fossil from the recent into distinct species—and elucidating any anomaly in their structure and condition.

As it is most material for the solution of the problem of their introduction and interment in Caves; and to ascertain the epochs of these events, to obtain a complete account of their situation, and condition in these places, and of other attendant circumstances, which though apparently unimportant, will on a general review, influence the final judgment upon these questions, it will be my endeavour to unite fidelity with detail in my statements—

The importance of this {condition} {caution} is enforced

by Cuvier in the following terms— “In every individual instance it becomes necessary to analyse and appreciate all those circumstances which might disguise the real origin of fossil organic remains, and it rarely happens that People who have collected bones, have been themselves aware of this necessity. The consequence of which has been that the true character of their Geol position has been almost always neglected or misunderstood (Cuviers Prelim Dis.)

[5]

Preface—

In the summer of 1825 Dr Buckland accompanied by Mr Northmore of Cleve visited the Cave of Kent's hole in search of bones— I attended them— Nothing remarkable was discovered that day, excepting the tooth of a Rhin and a flint blade— This was the first instance of the occurrence of British relics being noticed in this or I believe any other cave; both these relics twas my good fortune to find—but it was not the first case of the discovery of organic remains. Mr W. C. Trevelyan of Wallington had but recently dug out subjects of sufficient number and interest to form a plate, and I am assured that at a still earlier period Mr N had collected some single teeth of Hyæna— To this ardent inquirer therefore the priority of discovery belongs—I should not omit to mention Col. Henderson who casually alighted on similar bones while surveying the Cave— Dr Buckland had also on two former occasions made a search there, but owing to the want of leisure for pushing his inquiries, nothing new was developed.

By these investigations the presence of fossil bones was ascertained— The specimens however were meagre—the number of species limited and the circumstances of their condition remained still unascertained.

A few months after my first visit I resumed my researches assisted by Mr Northmore. On this occasion also I succeeded in bringing to light several interesting relics. They {served as materials for a plate arranged by Dr Buckland} {were esteemed by Dr B. of sufficient importance to merit a plate which was accordingly arranged}†—and among the results of this days excavation may be noticed the perfect jaw of Hy (the first discovered here) the teeth and bones of several species of Deer, Horse, Felis, Rodentia and Bird— Thus it

† [Copies of this plate were presented to the Torquay Natural History Society, by Messrs. Greenfield and Gardner, 1869. W.P.]

will be perceived the number of species was gradually augmenting with the †

Before {we come}{proceed} to treat of the remains under consideration it seems desirable to trace the discoveries of fossil bones through all their diversities [?] from their {lowest localities} {first appearance} in the inferior formations upwards to their presence in caves and superficial gravel—(This review may be attended with utility to those who have not applied their minds to Geol. investigations)—

Of the fossils {included in the latter situations} {last enumerated} a more extended history will be given when we come to speak of those from Kents Hole—that may enable the general enquirer to behold the singular relation resulting from their corresponding species, localities and vicissitudes which appear to have affected them—and the chain of analogy which connects the whole of these widely spread remains.

It is generally agreed that for solving the problem of their original introduction and their subsequent interment in these caves, and ascertaining the epoch of these changes it is essential to know precisely the position and character of the remains at the time of their exhumation—(circumstances apparently unimportant—but which alone at this distance of time can lead to a final judgment on these points) it has been thought necessary, tho at the risk of prolixity and repetition, to add copious details of the various phenomena deemed worthy of notice in the course of the workings—

The importance of this condition is strongly insisted on by the greatest authority in natural History—

“In every individual instance it becomes necessary to analyse and appreciate all these circumstances which might disguise the real origin of fossil or[ganic] remains—and it rarely happens that people who have collected bones have been themselves aware of this necessity. The consequence of which has been that the true character of their Geol. position has been almost always neglected or misunderstood.” Cuv. Discour. Prel.

Or as has been observed by the great example of inductive science, Men use commonly to take a prospect of nature as from a high turret, and to view her afar off and are too much

† [The lower half of the page from which the foregoing was copied was torn off and lost before the MS. came into my hands. The leaf was written on both sides, but it cannot be certainly concluded that the “Preface” extended to the second page. I have thought it best, however, to include in this “Scrap” the contents of the second and the next page. W.P.)

taken up with generalities—whereas if they would resolve to descend and approach nearer to particulars—and more exactly and considerably look into things themselves, there might be made a more true and profitable discovery and comprehension.

[6]

[First Discovery of Flint Implements in Caves]

In the summer of 1825 Prof. Buckland] accompanied by Mr Northmore visited Kent's Hole in search of bones. I attended them. The only thing of note discovered on that occasion was the tooth of a Rh and a flint blade supposed to a British relick—both of which it was my lot to find. This was the first instance of the occurrence of British knives in this or in any other cave hitherto examined, but not so of organic remains—Mr W. C. Trevelyan of Wallington had but recently dug out sufficient materials for a plate—and at a still earlier period it is affirmed Mr N. lighted on a few single teeth of hyæna.—To this gentleman therefore the priority of discovery would seem to belong—Dr Buckland had also on two occasions preceded me in investigating the cave—but was precluded by the pressure of his {avocations} {engagements} from carrying his inquiries on an extended scale—

These several essays served to establish the presence of organic remains—but their circumstances of their condition were still unascertained and even the number of species was limited

I resumed my researches in Oct of the same year. the result was the developement of some additional species and of superior specimens of those already known—Rh, Deer, Horse, Felis, Bird and several species of Rodentia now augmented the list and were recorded on the occasion in a plate arranged by Dr Buckland—

Thus it will be perceived new objects of interest were emerging to light with the progress of research—still these operations were by no means commensurate with the extent of the cave ranging over an area of eight hund. feet—Its contents moreover lay generally at considerable depths and were rendered nearly inaccessible by the thickness of the stalagmitic floor which everywhere overspread them—no satisfactory results could therefore be augured from a superficial search here and there—a thorough examination both of the main branches and of the most intricate involutions and secret recesses where many of the most precious relics lie concealed—yet remained a desideratum in science. Stimu-

lated by former success, I did not hesitate a moment to undertake it—but the work demanded a large acquaintance with similar phenomena and a constitution inured to fatigue and proof against the chills incident to sustained exertions in unwholesome vaults—In defect of others better qualified to accomplish the investigation I commenced digging at the close of 1825—and with little interruption have continued it down to the present time with unabated spirit—The results are now before the public—The remains of more than twenty species of quadrupeds including many rare specimens of the minutest no less than the largest, have been brought together under a single view, forming confessedly the most ample and complete series of cavern relics yet known—

The field of observation has been thus greatly enlarged—abundant materials placed before the stud^t of comparative anatomy, which enable him to verify previous conclusions founded on a display of fewer and less perfect subjects—regarding those characteristic features attributed to the fossil animal that discriminate them from existing races of quadrupeds and assign them a place among an order of beings now supposed extinct—nor should the collateral influence which the legitimate inferences of science exercises on the gravest of all deliberations be overlooked—The coincidence of Geol. facts with the relations of Revealed history is becoming more and more authenticated by observation—Nature every where speaks the same language with the sacred record—discrepancy may be traced to the spirit of the interpreters—such statements being deemed more at variance with Geol. facts than with inspired authority—How far the documents disclosed by Kent's Cave add to this principle will be best collected from the sequel—

[7]

Situation [of Kent's Cavern]

About a mile to the East of Torquay a by path breaks off from the new Teignmouth road, and in its course to the vale of Ilsham passes along the base of the cavern—a winding ascent to the right thro a copse conducts in front of its entrance, situated about half way in the face of the hill. The Hill is a flat cone—pierced in its north east flank by two apertures {situated} {placed} at * * * yards distance from each other. The surface is clothed with a thick skreen of shrubs seated in the naked crevices of the rock and at the base of the cliff penetrating thro the sides into the interior—

The cavern stands inland at an elevation of 200 feet above

the level of the adjacent sea at high water and its nearest point is * * * removed from the waters edge.

No river or stream flows in its vicinity—The Teign is the nearest and the only one in the surrounding district—it is six miles to the north of the cave—

There is no indication of deserted beds of former water courses within the range of the cave. The intersecting valies which traverse the neighbourhood of St. Mary Church and Ilsham pursue quite devious courses to it, its elevated position rendered it inaccessible to the sea and its remoteness from rivers from land floods. ordinary Land or marine floods do not appear consequently to have been instrumental in importing the sediment which fills the cavity of the hill—In this particular it is not liable to the exception taken against the position of Kirkdale, into which the contiguous fissures of which the Rical Beck is said to * * *

[8]

First Discovery

Having thus described the arrangement and dimensions of these respective connected chambers and their condition of the shell of the cavern as modified to their actual state by the process of incrustation, such as they appeared at the commencement of those operations we are now concerned to detail, we shall next proceed to lay open the subjacent region of mud and bones, following the natural division just laid down—viz. commencing with the common entrance thence advancing to the sloping chamber or trench [?] and finally to the upper and lower branches and their appendages—

[9]

first Search for bones

Common mouth, at the extremity of the lobby like passage extending from the common entrance the false floor of stalagmite is seen to spread under your feet—this was pierced through—it was found to be regularly laminated and ribbon like shaded with alternate stripes of red and white in proportion as the filtering matter happened to be more or less stained by red marl after rain in its passage thro the roof—the uppermost plates were discolored by external mould mixed with modern bones casually introduced by visitors—the average depth of this floor was two feet—it overlaid a bed of sandy clay intermixed with angular and rounded

stones the whole discolored with dark spots and emitting a fetid odour such as proceed from a disturbed pool of decayed vegetable matter—which on further inquiry was found to {arise} {proceed} from the decomposition of the fibres of shrubs which thro rabbit holes in the base of the rock shot horizontally into the loam and perished there—

About eight feet below the surface we came to flags of stalagmite lying in disorder, evidently the ruins of a preexistent floor, spongy and crumbling from long abode in the moist loam—and penetrated with a reddish color

Thro this bed were irregularly dispersed the jaws and single teeth of Bear, rabbit and Fox with splinters of Bones all so much decayed that they fell to pieces at the touch—neither so abundant or fresh as in the other branches of the cavern—This proximity to the mouth and air accelerated their decay—

The 3 offshoots to the right of this excavation are choked up with mounds of decayed vegetable mould mixed with bones and dung of rabbits and other such animals which retired hither to die—and dead shells of Turbos and Helix which hybernated in these recesses. The heaps of mould and quantity of stalagmite loading them

[10]

Modern remains—Bones ornament—Hum bones

In a pit in the stalagmite on the left of the excavation were discovered some Human bones reduced to carbon—a quantity of shells, and a curiously formed ornament made of bone, in form resembling a spear head—fig†—(arrows tipped with sharp bones of fishes, shells and tortoises were found to be used by the natives by Columbus Wash Ir—2-13—)‡

Pieces of pottery apparently fragments of an urn lay scattered about—the entire heap was overlaid by a slight pellicle of stalagmite—

Dr. Buckland has noted as occurring in the Cave of Paviland Swansea the occurrence of Human bones attened [? attended] by a group of shells and ivory ornaments made out of a fossil tusk of ivory lying near.—||

It is well known that the teeth and vertebræ of fish were in great repute as female ornaments in the last century—and what is more to the purpose they appear to have been applied to the same ornamental uses by our British ancestors—several

† [Not figured in any plate known to me. W.P.]

‡ [See W. Irving's "Life of Columbus," book 4, chap. 1, book 5, ch. 1, and book 6, ch. 2. W.P.]

|| ["Reliq. Dil." p. 88. W.P.]

strings of them have been discovered in the Wiltshire barrows by the late Mr Cunningham of Heytesbury—

[11]

Plum Clay or Loam,

a ferruginous marl composed of the shifting soil of the immediate external surface with which it is identical and while in a state of solution to have been precipitated from the turbid element during its tranquil settlement—The heavier contents having gravitated towards the bottom—the finer particles suspended in the fluid precipitated them forming a rich bed above and around the various materials it alighted on coating them with a sort of paste similar to that which invests rocks in muddy fens after the {retreat} {reflux} of the tide—

This was exemplified more particularly in a huge block of limestone which stood in the centre of the great excavation and pierced upwards the crust—the surrounding mud had subsided, but the rock alighted on a cross ledge coated over with a film of clay which indurated around it—

Red marl composed of calc sinter sand and clay—It is in its virgin state in the sloping chamber and upper division and is of a ferruginous red where it has escaped disturbance.

[12]

Perpendicular excavation in the central chamber

Sunk about the middle of great excavation where O.[?] R.[?] most abounded Stalagmite nearly 3 feet thick conglomerate of stones and calc sinter, the soil for the first four feet gravelly very moist. Great blocks and angular fragments of L[ime] S[tone] dispersed thro it—flint knives—Teeth and bones few—"This is surely sea sand" (said a mason)—The earth for the 4 following feet rather dry and mouldy and fine—masses of L[ime] stone—teeth and large jaws of deer, bones, fragments of Rhin lying thick in it—as has been remarked wherever it occurred—soil was observed to change in color—

[13]

Rubble—Remarks of Workmen

By the great movement of the volume of mud the thin covering of the floor was torn up and its wreck together with the bones strewed over it mixed up with the recent {mate-

rials} {diluvium}—I am aware that if a flood were now to rush in however impetuously it would not be sufficient to {rip} {tear} up the solid case—but in the first place from the general dimensions of the slabs, the stalagma was not more than one third the thickness of the existing floor—In the frequented Parts, the constant trampling of the animals would prevent its growth nor was the surface of such equable depth as it is now that are filled up the inequalities—this considered in conjunction with the pressure of such a weighty bed [?] upon the thin carpet of rubble and crust would force it downwards, as in the case of the Bears den and at the moment of dismember^t would commingle the shattered plates in the agitated mass—lying across the vacuum like bridges.

Entering by the subterraneous cavities at the base of the hill the swelling waters would force upwards the incumbent floor and scatter its ruins about. To some such cause perhaps is referrible the occurrence of the patches of the rubbly bed among the loam from which it is easily distinguished by its coarseness and sterility—

By whatever {movement} {agency} it was uplifted certain it is that insulated patches of it frequently occurred during the workings and it was common to hear one of the Party exclaim on meeting it—"I have come to the coarse bed—few or no bones—I must pass by it into the soft earth—

And e contra the same movement which elevated the rubble {supplied} {replaced} its place with the sandy loam; and by following its course thro the heart of the rubble the workman was sure to light on its {usual} {ordinary} fossil contents as a miner on certain ores in a particular vein—In these cases the experienced digger used to remark "Now I have passed out of the rubble into the fine plum clay again and its usual fossil accompaniments reappear in abundance—

While a third may be heard observing—This earth is dark and unctuous containing spots like charcoal and the usual attendants of the change, innumerable minute bones of Glires, a sure indication of the proximity of Foxholes.

[14]

[*Composition of the Deposit*]

*The siliceous or gravelly constituents vary in size—from the finest * * * * to the size of a pea—thickly interspersed with quartz and chert occurring in pieces of all dimensions to the size of my hand flat and rounded—but always smooth at the edges like waterrolled pebbles—*

The earthy matter contains an intermixture of animal matter with phosphate of lime and phosphate of iron, especially in the Bears den—

[Part of the page is missing. W. P.]

[15]

Upper Division [Grotto]

On one occasion my enterprising fellow labourer John Walsh visited the cavern alone, intent on exploring the floor of the side passages and small grottos which we reserved for the last to be examined—in search of treasure—On breaking away some loose mould containing fragments of pottery, he cleared away into the mouth of a small grotto situated nearly opposite the arched mouth—It is formed * * * a solid plate of stalagmite spread under—studded with numerous concretions which were joined by an infinity of calcareous icicles from the top.

He was tempted by the beauty of the grotto to enter which he effected by cutting away into the stalagmite which {nearly} {almost} choked up the entrance—Towards the interior it enlarged, but {scarcely enough} {not sufficiently} to allow of turning the body round even {on your face and hands} {in a prostrate position}—The first thing which attracted his attention was large shells inserted in the floor—their cup upwards as if to receive the drop—one of which remains still in its place—bones of fish whiting—Near them lay fragments of pottery, charcoal—the skeleton of a badger—Portion of the jaw of a Hog, including one of its tusks of enormous size—Balls of album Græcum and the barbed spearhead of iron fig†—added to the[m] in the midst of this singular assemblage—

The entire group was strewed over the surface of the stalagmite and some of them partially inlaid in its cells They were all encrusted with a reddish paste in the manner of the specimens from dropping wells—The Badgers-head and spear are beautiful examples of encrustation

It would seem that this secret grotto was a place of concealment.

[16]

Upper Division

From the Sloping chamber and its appendage the Wolfs Cave we should now ascend to the superior or Eastern Division

the ^{the} † [Not figured in any plate known to me. W.P.]

—It will be found to offer similar characters as regards the nature of the crust, deposit, and the condition of the remains, —it is therefore expedient not to separate their consideration.

The floor of this suite of vaults, is encumbered as has been before remarked with huge blocks inserted in the crust—and contributing to swell it into an average thickness of five feet. The difficulties of piercing through it were greater than even in those caves just examined—frequent attempts were made to reach the underlying deposit, if such existed—which were baffled by the intervention [of] impracticable masses occurring at every step—It was about to be abandoned as hopeless when the following circumstance led to its * * *

Some red earth was observed to be dispersed in patches over the floor—which at first was supposed to be nothing more than the loose mould scattered about from the adjacent excavations or attached to the shoes of visitors—but when it was perceived to be covered with a film of paste and to spread over the stalagmite in the form of a layer it excited particular inquiry supposed to be the actual region of diluvium—when closely examined it was discovered to contain a curious assemblage {of} {referrible [to]} different periods—The remains of Rhin. Horse Deer, and Hyæna mixed up with decidedly modern heads of Dog, Sheep, Badger—and the scales of Beetles in nests—farther search developed relics of art viz circular pieces of slate, of pottery, both ornamental and culinary—lumps of virgin copper ore, the particular description of which we reserve for the more detailed consideration of antiquities in another place.

Removal of this singular stratum laid bare an under surface of stalagmite—it was found to be perforated with burrows like those in the other caves—By following and enlarging which we were enabled to arrive at a stratum of loam—

The depth of the crust at this point was four or five ft.—composed chiefly of large and small angular stones agglutinated by the infiltrations—among which were discovered remains of Hog—Deer—Fox and patches of charcoal black mould virgin ore—and towards its junction with the red loam flint K[nives]—

The vertical holes ramified into horizontal canals, stretching sewer-like through the field of the loam, intersected at right angles by cross branches—The main excavation runs parallel with the eastern side of the rock—and from the current of air constantly issuing at their mouth would seem to open externally in the base of the cliff.

These subterranean mines are accessible for many hundred

yards—The path however lies frequently over suspended rocks from which the earth has crumbled away—They retain a slight sprinkling of earth sufficient to give them the appearance of a floor but deceitful as pitfalls—communicate with chasms into which were discharged some dozen cartloads of loam without diminution.

There is no difference in the deposit from that in the caves described—it appears a part of it similar fragments of strata, gravel, sand and mud—The remains are rather scarce. There were a few superb fossils however dug out here—The singular jaw of Hy united by symphysis, shewing the advance of a new tooth laterally to supply a diseased one in the act of absorption. Elep. teeth, young Horses jaw &c.

The remains like the deposit furnish no point of difference—the ordinary sharp and truncated portions of bone—bearing decided marks of gnawing—splinters and album græcum, among all which were detected a few entire specimens (viz. young Hy. jaw) that escaped unbroken and ungnawed.

Rabbits burrows pierce the external face of the hill at every step—hillocks of red earth are thrown up round the edges—it was evidently forced outwards in their egress from the cave, it is of that soft and crumbling character of the mud of the interior with which it appears identical. These apertures are now choked up with gravel and underwood with interlacing roots—they must have existed at the time of the influx of the mud—for burrowing animals only found them filled up with mud—and served as embouchures for animals and inlets for the enormous diluvium—The system of excavations horizontal and vertical communicate no doubt with them as appears from the cross currents of air which traverse them. The general level of these horizontal excavations is generally about 15 ft. below the surface of the floor—which corresponds with the burrows in the face of the cliff—

It is probable that they were first commenced by rabbits which were dispossessed by the Fox whose habit it is [to] invade the burrows of other animals and not to dig any itself—

Along the area of these canals bones were discovered lying naked on the floor or projecting from the sides one of their extremities being infixed in the mud or attached to the stalagmite of the roof—Bones of rabbit, sheep and Fox on the surface—discolored to a dusky shade—the loam arid, pale and pulverulent—

Accident

I had scrambled to the depth of a hund ? feet thro the main

canal near the second mouth—and noted the ramifications and appearances as I proceeded—while engaged in breaking the earth, I burst into a lateral *shoot* the mouth of which had been closed up with mud—a gust of impure air rushed up from it, put out my light and struck me insensible—The workmen who were deterred from entering themselves and endeavoured to dissuade me from the undertaking luckily stationed themselves at the mouth and {observed my danger} {perceived my predicament}—I was drawn out in a state of insensibility—and it was not till after some hours exposure to the air that I recovered but the effects of the accident lingered for a long time after—The men complained of the foul air and felt a tendency to sickness—

[17]

Superior Division

We are tempted to break thro the order of excavation implied by the proximity of the chambers on the line of the Inferior Division and ascend to the Superior or Eastern Section—The similarity of results which these branches disclose, renders it expedient not to separate their consideration.

From the insertion of fallen masses in the floor the crust was swollen to an average depth of five feet—in some cases huge flakes of rock alternating with the stalagmite stretched across the area and debarred access to the region of mud—Rock after rock was ripped up and the object of our search seemed as inaccessible as ever—Many days were lost in useless labor—and this branch was about to be abandoned as unpromising and impracticable when the following circumstance led to its investigation—Small patches of red earth were remarked to be distributed over the surface but excited little attention from the impression that it was nothing more than the loose stuff of the adjoining chambers that attached itself to the shoes of visitors—when however it was found to underlie the large rocks that for centuries prior to the commencement [?] have lain undisturbed and engrafted in the floor, and in the retired places to be overlaid by a film of crust it called for particular inquiry—After clearing away the rocks it was ascertained to be about a foot thick—and to contain a miscellaneous assemblage of relics of divers periods—such as the modern bones of Dog, Fox, rabbit, Badger—nests of the scales of Beetles—next were developed works of art—viz circular pieces of slate or Beads—a quantity of broken pottery of the culinary and ornamental kinds—lumps

of virgin ore—the particular description of [which]† is reserved for a more detailed consideration of antiquities in [another]† place—

[18]

[*Sally Ports*]

The circumstance of their penetrating beneath the slope of the hill and of their serving as an avenue for foxes into the body of the cavern makes it probable that they open externally in the base of the hill and served as entrances into * * * concealed perhaps by the underwood or choked with gravel—

While engaged in seeking for their external openings in the corresponding surface of the hill, some rabbits darted out of the bushes and {betrayed} {disclosed} the {entrances} {communication}—There are two borrows at the distance of a few yards, round the mouths of which were heaps of red loam thrown out from the holes of the same description as that in the interior—

[19]

[*"Portholes" in the Cavern Walls*]

On further examination I found that the rocky cover of the cavern is perforated with numerous crevices or windows, partly choked with mud and brambles thro which at so many portholes the mud in a state of fluidity may have entered into the common reservoir of the interior—a pool of liquid lead, flood of lava or Plaster of Paris

[20]

[*Kent's Hole unlike Oreston Cavern*]

In Oreston Cave it is true in some vaultings discovered in 1816 the bones of Rhin prevailed exclusively—and in those opened in 1820 those of Bear prevailed—while in the contiguous cavities of apparently coeval formation, Deer and Antelope only were found—but in the course of 1822 the bones of several distinct genera were found congregated together, viz Bos, Deer, Hy, Wolf, Fox—these cavities communicated with each other—and the bones of the different graminiv^a animals were found collected together in the same cavity—but those of carnivora at a considerable distance from each other. but Dr. B. in his Reliquiæ Dil, satisfactorily explains this anomaly by the hypothesis Page 78 that the animals had fallen during the antediluvian period into the

† [Part of the leaf torn off here. W.P.]

open fissures and there perishing had remained undisturbed in the spot on which they died, till drifted forwards by the diluvian water to their present place in the lowest vaultings with which these fissures had communication—This explanation is supported by the strong fact that animals at this day do fall continually into the few fissures that are still open, and that Carnivorous as well as graminivorous animals lie in nearly entire skeletons in the open fissures at Duncombe Park each on the spot in which it actually perished upon the different ledges and landing places that occur in the course of its descent and from which if a second deluge were admitted to this fissure, it could only drift them downwards, and with them the loose angular fragments amidst which they now lie to the lowest chambers in which the bottom of this fissure terminates."

But in no part of this cave and least of all in this vault closed overhead by a continuous† * * * * could there be remains admitted thro in the manner above described† * * * were there chasms in the roof for the† * * *

[21]

[*Kent's Hole unlike Kirkdale Cave*]

Nor have those water-worn characters of the rock been here noticed that some observers have remarked in the floor of Kirkdale. The sediment furnishes no evidence of exclusive deposition whether from terrestrial or marine inundations—There are only two instances of marine exuviae—fragments of the ostræa—none whatever of freshwater shells in the same deposit—There were a few land shells belonging to those species that are known to retire hither to hybernate—*Helix*, *Turbo*.

The crest and sides of the hill have been recently partly exposed by the removal of the shrubs—no large cracks or fissures were visible along the surface—The usual effects of long exposure may be observed in carious inequalities encreased by abundant {precipitations} {transudations} of calcereous matter into the interior—after rains these infiltrations are copious and in some places colored with a solution of red marl or vegetable soil—and furnish the only communication with the external surface—insufficient for the transmission of any considerable substance from the top, much less of the enormous deposit of the vaults below—we can no where trace

† [The lower part of the page on which this fragment occurs is torn off obliquely, and with it certain words as well as the close of the passage. W.P.]

mud or bones in the niches or ledges of the roof and sides calcareous matter alone invests them—a solid case of rock on every side {encloses} {environs} this cavity—In this particular likewise it differs from the caves of Oreston and Kirkdale—

[22]

[Introduction of the Fossils.]

On the Hypothesis that floods or currents (supposing that the cave was accessible to their irruptions) were the vehicle of their introduction, we would look for the bones in greatest quantity or at least in equal abundance in the caves nearest the mouths where they were likely to be intercepted—but in these situations they are very scarce—and in the interior we should expect to find them equally diffused thro the several chambers— Now in some of the grottos they are collected in heaps—viz in large caves and Wolf's cave— In others are almost entirely wanting as along the arcade—

They would likewise be in differently formed fragments—some sharp—some rounded—but through the entire there is a uniformity—

Bears Cave

In all branches of the cavern alike they would be found mixed confusedly together— now in the Bears den the remains of that animal prevail exclusively— The mud therefore merely flowed over them, round them, or where its force was not broken by opposing rocks, {swept} {impelled} them against the opposite walls.

Again bones transported from a distance would lose in their march the projecting processes—the ridges and profiles of the jaws would be rounded—the alveoli dismantled of their apparatus of teeth—the large and solid bones eroded to shapeless boulders as is the case with the Eleph teeth and bones derived from the disintegration of the Sussex and Dorset cliffs—which after storms are cast back by the surf on the beaches—and all the more delicate specimens would be comminuted to powder—the entire mass of animal remains would be more, or less modified—but &c.

The organic remains existed therefore within the limits of this system of caverns and were not introduced by floods or currents—but had been spread over the floor at the epoch of the influx of the mud and gravel which in its course swept them up and entangled them

[23]

[156c]

[Introduction of the Fossils]

Supposing for a moment that the bones had been injected into the Cave with the mud, what will be the inference respecting the countless animal Population of that period, if a patch of mud which was detained in a space comparatively small contained thousands of nearly every species—there is not a cubic foot that is not as if alive with them

It is rather singular that similar patches of mud enclosed too in caves and pits are either entirely destitute of their remains as at Buckfastleigh, or contain them but sparingly and those in entire carcasses as at Oreston—or in numbers as at Kirkdale where it has been proved to demonstration they were similarly deposited as those in this cave—

[24]

Nuts

but the nuts would seem to have been introduced at subsequent periods by mice which thro the Fox holes found access to the centre of the diluvium and there hoarded the fruits collected at the mouth of the cave where they at present grow—The nuts in the heaps besides are much better preserved and appear to have been quietly deposited by the small animals whose skeletons I have found entire in the crevices of overlapping rocks which fell from the roof where they retired to die. They differ from those which accompany the great depots of bones not only in the state of their preservation but also in species—the former being the domestic the latter the water rat?—Campagnol—

It is superfluous to observe that the fluid which dispersed the single nuts which probably were formerly likewise collected {in heaps} {in clusters} and the bones of the Rongeurs, would not have spared these stores—which circumstance of itself is alone sufficient to indicate their comparatively modern deposition—

Both descriptions of nuts are pierced at one end, thro which the kernels appear to have been extracted—

This may be considered as an additional argument of the quiet occupation of the Cavern at the period of the sudden inundation of the fluid—

[25]

Character and Condition of the Fossils

Several specimens belonged to the young of the different

{animals} {species}. All bones with their epiphyses yet unconsolidated, but still adhering—and jaws or rather mere membranous shells enclosing the rudiments [of] second sets of teeth advancing beneath the milk ones which themselves are still standing as may be seen in fig. Plate† and which with the least removal or violence would have fallen out.

Such likewise are the delicately-edged and compressed teeth of the *Ursus Cultridens* P. Fig.‡

and numerous other specimens which after the extraction of their marrow (elemental) parts and destruction of the softer portions of the bone fell from the *Hyænas* jaws to the ground and there tranquilly remained freeing themselves from the remaining animal matter, {when} {until} they were suddenly encased in loam and thus embalmed transmitted to us in their actual state to our time—

[26]

Condition of the Fossils

but tho the fragments were disjointed and unconnected with the other members of the skeleton, many appear to have escaped the *Hy* been not altogether divested of their flesh at the time of their inhumation—they appear in the condition of macerated bones from which the flesh slowly moul[dered]§ away after their sepulture, depositing around them a dark shade emitting the effluvia of sealed up animal matter—

Their surfaces exhibit the cartilaginous impressions of the blood vessels in strong relief and the marks of the play of the muscles which could only result from the tranquil decomposition of their fleshy covering—

No modern preparation however carefully executed can scarcely equal, certainly not exceed the entire preservation of the most fragile and prominent parts of a great majority of the bones.

[27]

[Possibly occupied by Hyæna and Bear at a comparatively recent period]

It is not improbable that subsequently to the period of the deposition of the mud, the *Hyæ*, as well as *Bear* {retired} {still continued}, like their Predecessors to this part of the cave, as do the *Bears* of the *Carpathians* to the present day,

† [Probably figs. 6 and 8, Plate M "Cavern Researches." W.P.]

‡ [Plate F "Cavern Researches." W.P.]

§ [Part of the leaf torn off here. W.P.]

till the inroads of civilization extirpated this race like the wolf more recently from Britain—

Nor is it unlikely that that period was very remote, as in the very bed containing their bones a rude, knife shaped piece of iron was detected much corroded—

Found strewn over the surface in a rubbly mould of a dark brownish color like the covering of the bones in Gaylenreuth—teeth and jaws of Bear with incredible quantities of *A.G.* [*album græcum*] of equal freshness with the bones

The total absence too of the bones of the Eleph^t Rhin, Tiger in this chamber, and the occasional occurrence of a Horses or Oxes bone (broken and gnawed like those in the Great Chamber tho yet fresh and recent) confirms the conjecture that the last inhabitants of this cave were Post Dil. Bears which continued to possess the cavern at a period after the great Quadrupeds had long ceased to exist—

The thickness of the plate of crust, compared to the depth of that which covers the congregated remains in the other central chambers should not be overlooked in estimating the period of the last occupation of this den by Bears—

It is remarkable that entire arms and femora of bear have been found {slightly} {superficially} engrafted in the crust or lying loose upon it—light and porous and discolored—quite fresh when broken—

[28]

Flints†

	36
Buck	1
Geol S.	2
Mrs. C—	6
Mrs D	2
Mr B	2
Mr Wel	3
Fam	1
W—	1
Char—	3
Brah—	1
	—
24	
36	
—	
60	

† [Apparently a list showing the number and distribution of the Flint knives found in the cavern. W.P.]

[29]

Inscriptions—

There are innumerable inscriptions chawked and engraved on the walls and knolls of stalagmite on the floor. They may be traced from the present moment thro the last three and four centuries—and exhibit specimens of Roman, Greek and German characters—it is curious to observe the slow progress of incrustation as indicated by them— In some a letter or a syllable is overlaid by a thin membrane as it may happen to lie in the current of the trickling drop—in others the entire inscription is glazed over—but still the fluid following the indentations of the characters has left a faint track of the original—the characters remaining still faintly visible thro the film.

In the entrance lobby are still legible the dates 1624—A. I. 1684—W. Way. 1782—

The inscriptions in the grotto near the mouth have partly disappeared under the rapid advance of the * * * * which in the elevated * * * of the cavern accumulates very rapidly—it is impossible to decipher the dates with certainty—there are a few pretty visible of the 17 and 18th centuries— The ancient style of numbering with letters is employed in two or 3 places—M—D—X

There are numerous names and dates of the 17th centy.— On the large block of stalagmite in the cul de sac we read the following—

John Martyn 1619— R:B—1661—

Peter Lemaine
Rich^d Colley
of London
1615

In German characters

Ambrose Lane
Mildred
Torkinton

Robert Hodges
of Ireland
Feb 20—
1688

The letters * * * * in the inscription of J Hodges are overlaid

[30]

Note on Zigzag Rout.—[Bewildered Visitors]

Of the dangerous intricacies of this section of the cavern a memorable and nearly fatal illustration occurred during the American War— Some officers of the fleet then stationed in Torbay had the hardihood to attempt to explore it without a guide—Having soon lost their clue they wandered about in the vain hope of retracing their steps during which their torches were burnt out. They then groped about in different directions and separated—after a night of horror, they were released by their friends who alarmed at their absence, recollected the projected adventure and hastened to their deliverance—

As indicating the popular * * * * of the indefinite range of the cave may be noticed a tradition which is seriously told and believed— It is related that Sir Geo Cary an ancestor of the present Proprietor of the neighbouring abbey—dispatched a hawk with billet and bells, in the hope of discovering its farthestmost outlet towards the sea—The hawk was taken on the coast of Kent from which circumstance it is gravely affirmed it takes its name—the real origin is not known—

[31]

[145c]

Reasons for the discovery of Flints in Caves

The savage hordes whose primitive mode of life led them to range the country in pursuit of game would naturally {chase} {follow} it into its retreat in the open fissures and chambers of the rock—and finding them securer shelter against the seasons and still less friendly tribes, as well as a more convenient ambush for watching and surprising their prey than the surrounding surface afforded, would seek to dislodge its inhabitants and adopt these subteranean vaults for occasional if not permanent abode—and in those districts the compact nature of whose strata is unfavourable to the existence of these natural cavities in the rock we find that the early inhabitants of Britain excavated artificial caverns for their habitation. "From the softness of the red sandstone it has been frequently hollowed out into extensive artificial caverns, such as those near Nottingham which as they gave rise to the name of the place Snodingaham "The home of Caverns" must have been of great antiquity; probably may have formed the dwellings of the rude aborigines—There are similar but smaller excavations at Knaresborough, Yorks.

and at Guys Cliff, Warwick—and in the parish of Addingham (Cumberland) the Druidical temple called Long Meg and her Daughters were excavated out of red Gritstone"—Conybeare 280†—and Polwhele Vol 2 or 4—

[32]

The presence of Druidical reliques attests &c—

[147c]

Various arguments concur to show that the Cavern reliques are referrible to the epoch of the occupation of Britain by the same people who raised the barrows and interred in their sepulchral urns precisely similar blades.

Between the flints found in the barrows in Wiltshire and those collected from the Caverns of Kents Hole, Anstis Cove and Berryhead, there is a singular identity both of material and form. Excepting that the barrow specimens have a more polished edge apparently from friction on a flag, but exhibit no other evidence of superior art.

None of the cavern blades appeared to have been rubbed or polished, but exhibit the rough serrated edge of the original fracture—this difference alone may not be sufficient to authorize us in assigning to the cavern reliques a higher antiquity—but the absence of other Druidical remains at the depth where the flints abound is a negative confirmation—

But in a dark mould mixed with disturbed loam strewn over the floor of the upper division there were detected various articles which appear to be identical with those found in the barrows alluded to, viz. Fragments of sepulchral urns, which exhibit the zigzag mouldings of those from the Deveril barrows fig in Mr. Miles memoir. both are formed of a coarse clay—sunbaked and turned on a lathe—and this analogy is rendered complete by the discovery in the cavern in association with the pottery, of circular pieces of clay slate, perforated in some instances, in the centre like the coal money found under similar circumstances in the barrows—

[33]

Kimmeridge Coal Money

[149c]

The circular pieces found in Kents hole and Berryhead are composed of schistose slate—and clay slate—but the pieces from the barrows consist of Kimmeridge coal—a fetid unctuous substance—For the uses to which they would appear to have been applied, the nature of their substance was a

† ["Outlines of Geology of England and Wales," part 1, book ii. chap. iv. p. 280. W.P.]

matter of indifference convenience alone seemed to regulate the selection—In the extensive potteries which at a remote period were carried on in the neighbourhood of Kimmeridge, circular plates of that coal were employed as centre pieces or bases for moulding the vases upon—as these nuclei could not be separated from the bottom without injury they were left enclosed in the overlapping clay and in this position became indurated. I am not aware that they were found in the position described, but the corresponding impression of them was observed—and when the urns were decomposed or {destroyed} {broken}, these parts fell out and being of a more durable material were preserved—

The circumstance of their circular form and their occurrence like the oboli of the ancients in sepulchral urns gave rise to their popular appellation of Coal money—Vid observ. on Pott—zigzag &c

Notwithstanding the similarity existing between these different reliques, it is rather strange that flint knives have not been found intermixed with them on the surface—nor pottery found with the knives under the crust—but they were traced in a *shingly bed* cemented by stalagmite which overspread the loam—and also in the loam itself in contact with the bones—but only in one instance was pottery found in the same situation with the knives, from which circumstance I am disposed to think that the flints were of a far higher antiquity than the pottery and circular plates pins and beads—introduced only at subsequent distant intervals.

[34]

[166c]

Wokey Hole in the Mendips

Human bones and sepulchral {urns} {cists} found—the found in mud decidedly fluvatile as the bed of the cave is accessible to the highest floods of the adjacent river.

[35]

[7a]

Cave of Bize in France

M. M. Tournal and Marcel de Serres found the mud to contain abundant fragments of pottery referrible to the Etruscan period—(so also in the Cave of Kents Hole—)

Sometimes these bones are in a state of *alteration*—seldom connected—not gnawed—only 1 tooth of a Carniv^a. An.—no Album G—The animals differ from the population of the Caves in France, Engl^a. and Germ^y.

Human bones found in the same black mud with the

animal—have lost their animal matter—*Land* shells of which some species no longer live in the neighbourhood,—Modern marine shells, pottery, pebbles of green sandstone and white and grey limestone—Charcoal—so also H[uman] bones, Land and marine shells here, but in *distinct* strata. M. T. contends that all of the objects contained in the mud and breccia are of the same date. at a certain Epoch the first cave was entirely choked up—and hence the breccia which invests the roof—in the second cave the roof being much higher, the mud did not reach so high but every thing indicates that the mud attained a much greater elevation than that of its present level—(the same is exemplified here) The caves supposed to be filled during the period intervening between the times of Geol. formations and the historical times—All, the mud and bones more modern than the contents of the Lunel Viel Cave?

During that interval between the deposition of the mud in the cave of Lu[nel] Viel and of that which has filled the caves of Bize, the animals which inhabi[ted] France had undergone great changes?—

Some species have disappeared since the commencement of the Histor^l Times. Man existed at the period of the filling of the Cave of Bize.

[36]

Artificial B.[ritish] Caves

In the hill of Karnbre Cornwall a place remarkable for its assemblage of almost every species of monument pertaining to British rites and customs, Dr. Borlase says that among “rock basons, circles, stones erect, remains of Cromlêhs, Karns, a grove of Oaks, and enclosure, not of military, but religious structure,” he perceived a *cave*, “evidences sufficient of its having been a place of Druid worship”—in confirmation of which the adjacent town [Redruth] divided from the hill only by a brook “was anciently called Red-drew, or more rightly Ryd-drew, i. e. the Druids ford”—†

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Artificial Caves

Rocky cells or caves at Wetheral in Cumberland—Archæolo. Vol. 1.† Bishop of Lyttleton (of Carlisle) in a paper on stone

† [“Antiquities of Cornwall,” p. 120.]

† [A Letter from William Milborne, Esq., of Arniathwaite Castle, concerning the Cells at Wetheral in Cumberland. Read April 17th, 1766, “Archæologica,” vol. i. pp. 84–6. W.P.]

hatchets and mallets† in the 2 vol of the Archæ 119 says—1° “There is not the least doubt of these stone instruments having been fabricated in the earliest times, and by a barbarous people, before the use of iron or other metals was known.”

“The most extraordinary discovery of this kind that was ever made in this part of Europe, or perhaps in any other, is recorded in Père Montfaucon's *Antiquité Expliquée*, In the year 1685 Mons Cocherell, a gentleman living at a place so called in the diocese of Evereux in Normandy, caused to be opened an antient Gaulish sepulchre, situated on his estate there. After removing some very large stones, two human skeletons were found, the skulls of each resting on stone axes or hatchets, one of which was a pyrites, measuring about seven inches long, and one and a half broad, worked to the finest edge, and sharpened at the corners. The other ax was of an oriental stone, called *Giadus* These bodies rested on a flat stone, which being removed, two others presented themselves with the like stone axes under their heads, exactly resembling the former, as to shape and figure but of a different kind of stone. These last bodies were accompanied with three urns filled with coals, or, I should rather suppose, with wood burnt to a coal. The workmen proceeding still further, and extending the pit or cavity to a greater breadth, discovered sixteen or eighteen more bodies, all laid in a regular order, in the same line, with faces towards the south and an ax or hatchet under every head. Near the bodies lay three spears, or lances made of bone, and one of them evidently of a horses shank bone, together with several arrow heads, some made of bone or ivory, and others of stone.”‡—It is conjectured that the jade stone axe marked the superior quality of the deceased—perhaps a chief—similar are dug up in the Netherlands—Picardy, Artois and other parts of Lower Germany, Halsatia and Denmark—

“Sir W. Dugdale, in his History of Warwickshire, also gives us the icon of one found with several others in an old fort (as he styles it) containing seven acres of ground, at Oldburg in that county. ‘They were (says he) about four inches and an half in length, curiously wrought by grinding, or some such way; one end is shaped like the end of a pole-ax,’ and he thinks they were weapons used by the Britons before the art of making arms of brass or iron.”§ Bishop Lyttleton goes further and is “persuaded that when they fabricated these

† [*Observations on Stone Hatchets*, by Bishop Lyttleton. Read at the Society of Antiquaries, March 6th, 1776. Ibid. vol. ii. pp. 118–23. W.P.]

‡ [*Ibid.* pp. 118–120. W.P.]

§ [*Ibid.* p. 120. W.P.]

stone weapons they had no knowledge at all of these metals ; and that must have been at a very early period indeed, as in Julius Cæsar's time they had abundance of *scythed* chariots, which probably were introduced here by the Phenicians some ages before ; since the Gauls, who together with the Britons had one common origin, had no use of these chariots."

"How low an idea soever some people may entertain of the Ancient Britons, they can hardly be thought so barbarous and ignorant as to have made their battle-axes and spear-heads of stone, and this with great labour and difficulty in the execution, when, at the same time, they were mechanics sufficient to make iron scythes, and had such plenty of iron as to arm their chariots of war with this destructive weapon."† On the whole he is "of opinion that these stone axes are by far the most ancient remains existing at this day of our British ancestors, and probably coeval with the first inhabitants of this island."† at the conquest of S. America the people were ignorant of the use of iron and supplied its absence with instruments of stone—So also in the Sandwich Islands—

There are some who consider them to have been used for slaying victims for sacrifice and in support of their opinion adduces that passage of Livy when speaking of the Roman Pater Patratus who was sent by Tullus to make a league with the Albani, he says "*Porcum saxo silicé percussit.*"†

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[Pen Pits]

[144c]

In the Southwestern extremity of Stourton Parish, Wilts, there is a large tract perforated into numerous hollows or excavations, which are popularly called Pen Pits. Several thousand holes of various forms and dimensions extend over a surface of nearly 700 acres of ground. They are found on the brows and slopes of two hills, between which is a narrow valley. On a bold knoll, projecting into the valley, are traces and banks of an ancient encampment. These pits resemble, in their form, an inverted cone, and are of unequal dimensions. In some instances they appear double, or only divided by a very slight partition of earth. The most likely supposition is that they were permanent habitations. The custom of living under ground is of very high antiquity, and is still practised by the inhabitants of Kamskatcha, and of other countries.—Brittons Wilts. §

† [Observations on Stone Hatchets, vol. ii. p. 128. W.P.]

† [Livy, lib. i. cap. xxiv. W.P.]

§ ["The Beauties of England and Wales," vol. xv. pp. 286-6. W.P.]

The inhabitants of the upper region of Atlas live four months in the year in excavations of the mountains—viz from Nov. to Feb. inclusive—Rees Ency Article Morocco.

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Pen Pits—or Pits excavated at Pen on the banks of the Stour Sir R[ichard] H[oare] † thinks that the entire plain was excavated into pits—they are in form like an inverted cone—very unequal in their dimensions—in some instances there are double pits divided by a slight partition of earth—the custom of living under ground is of high antiquity—and is thus alluded to by Virgil in the Georgics

“Ipsi in defossis specubus secreta sub alta
Otia agunt terra.” ‡

and the same habits continue in Kamskatka—&c—

This circumstance most probably suggested the name of Selwood, or “wood of habitation” to a part of the tract on which they are situated. Similar pits occur at little Coxwell in Berkshire over about 14 acres of land and are 273 in number. Leland mentions some pits on the black mountains, Carmarthen, others are said to occur near Honiton. Lot after he went up out of Zoar, into the mountains, dwelt in a cave, he and his 2 daughters—showing that even in Patriarchal times caves were resorted to as dwelling places—and that caves were used as a burying place is shown by Abrahams interring Sarah in the cave of the field of Machpelah, before Mamre which he purchased of the sons of Heth—and all the trees that were in the field—in all the borders round about: Gen c. 23—v. 17—in which he himself was afterwards laid by Isaac and Ishmael—

Hunting—Archery Patriarchal occupations and Agriculture.

Job in chap 30 thus delineates the condition of the Fathers of a race of men who were his contemporaries—supposed to apply to the Exiles from Babel—“The scattered over the face of all the earth” “Who cut up mallows by the bushes, and juniper-roots for their meat. They were driven forth from among men, . . . To dwell in cliffs of the valleys, in caves of the earth, and in the rocks” §—

[40]

Aspect of Indian Caves

“The grand Entrances of Stonehenge and Abury are placed

† [“Ancient South-Wiltshire,” pp. 35-6. W.P.]

‡ [Georgics, lib. iii. v. 376. W.P.] § [Job xxx. 3-6. W.P.]

exactly North East as all the gates or portals of the ancient caverns and cavern temples were" Ind. Antiq. (Maurice)

[41]

Penpits the work of the Romanized Britons after the cessation of interments in Tumuli—

Pits near little Coxwell in Berkshire which cover about 14 acres and are 273 in number. Mr. Daines Barrington conceives the area to have been a considerable city of the Britons at the most ancient period.

Leland also mentions some in the Black Mountains, Carmarthen and others are said to be at Honiton in Devon.

That there existed at this infant state of society a similarity [?] of habits is not improbable—as their tongue was the same, "and the earth was of one tongue and of the same speech."

[42]

Caves of interment in Loo Choo

[166c]

Basil Hall 137

"The rocks here rise in perpendicular rugged cliffs of coral, with a number of rude square excavations on its face . . . Most of these caves were closed up by a wall of loose stones, but in one, of which the mouth was open, several human bones were found lying amongst the sand. On removing a stone from a closed cave, a vase was observed in the inside, of an elegant shape; the people signified to us that these were the remains of the dead."†

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[Cavern of Breingues]

[166c]

In the cavern of Breingues in the Department Du Lot bones of Rhin, Ox, Deer were found artificially arranged round the walls of grottos—the aperture to which was closed by overlapping flags brought from the outside—In 1816 the whole population of Breingues was occupied in searching for treasure, which they were sure of finding on coming to the flags above mentioned, instead of which they found the bones—M. Dupon supposes that these grottos were used by the Druids for performing their ceremonies in them and the bones to be the remains of the sacrifices—The regular arrangement may be referred to the superstition of the first

† ["Account of a Voyage of Discovery to the West Coast of Corea, and the Great Loo Choo Island." By Captain Basil Hall. London, 1818, p. 76-6. W.P.]

inhabitants of the country who first discovered the bones and carefully placed them in the fissures of the rock or to the amusement of herdsmen. This latter opinion is countenanced by the discovery of a human body beside which was an iron instrument resembling a fork with two prongs—

[44]

Twin Barrows—

Situated to the S. West of Everley between two Roman ditches are two barrows called *Twin Barrows*, from their resemblance to each other, and the peculiarity of their being environed by the same ditch. "One of them, opened by Mr. Cunnington in 1806, was found to contain only an interment of burned bones and a bone pin; but its companion which was explored in 1811 by Sir Richard Hoare, presented some peculiarities worthy of notice. It had no sepulchral deposit, but on approaching the floor an immense stratum of burned wood ashes was discovered, rising in the parts nearest the centre, to the height of three feet. The whole quantity amounted to a full cartload; and was intermixed with bones of animals, chipped flints prepared for arrows or lances, and some bone ornaments." The first appears to have been honored with the sepulchral deposit, and the other only with the ashes of the funeral pile. Britton †

On the summit of Cawsand Dartmoor there are two barrows or mounds—the {inclosure} {circle} is made of blocks of granite as are those of the mountains of Daouna described by M. Patrin. one of the barrows was opened.

[45]

Barrows

Isidore speaks of them as being in general usage. Apud majores Polentes [?] aut sub montibus aut in montibus sepeliuntur—Bell in his travels thro China notices these sepulchral hills,† and in Cookes Visit to le Tooga [Lefooga]|| one of the friendly he observed one of extraordinary size. All the old writers of the north are diffuse on this head in Greece, Tartary—Russia

† ["The Beauties of England and Wales," vol. xxii. p. 406. See also Sir R. Hoare's "Ancient South Wiltshire," p. 193. W. P.]

‡ ["Travels from St. Petersburg in Russia to Diverse Parts of Asia." By John Bell, Esq. In 2 vols. London, 1764. Vol. i. p. 221-2. W. P.]

|| ["The Voyages of Captain James Cook Round the World," in 7 vols. London, 1809. Third Voyage: vol. v. book ii. chap. vi. p. 298-9. W. P.]

[46]

Cromlechs

Thus Olans Morinius—Sed neque veteribus Gothis aliisq. gentibus in septentrione defuit memoria majorum—quin et iis exhiberent, quos humi recondere placuit—mira compagine immensa saxa, in modum altissimæ latissimæque Januæ sursum transversumque viribus gigantum creata

The same author considers cromlêhs to be *Altars*

“Ararum structura apud nos ē varia—Maxima a parte conjestā a terra constant tumulo, in cujus summitata tria ingentia saxa, quartum, illudque majus latius ac planus sustinent, fulciunt ac sustentant, ut instar mensæ tribus fulciis innixæ emineat—

but Dr. Borlase regards them as sepulchres, tho he has found no evidence as pottery

Cist vaen are decidedly sepulchral as its name implies.

[47]

[*Remains in Barrows*]

Polished pebbles of an oval form occur in the Pottery mould of the barrows of Wilts—Beauties of En. & W—Vol 2 [? 1 5] 453—used as missiles in slings

Beads of blue and green opaque glass “sometimes of a long” are found in barrows—in this excavation near the mouth we find oblong beads of a white opaque crystal—and the fragments of others—Iron and brass nails with flat heads.

Sir R Hoare found in the Wilts Tumuli oblong pieces of blue slate perforated—I found at Berryhead the half of a circular piece perforated in the centre fig^d.—

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British Reliques

[146c]

British beads chains, iron rings and brass bits of bridles were dug up in a quarry (in cave ?) at Blankney Lincoln^a and Roman armour accompanied with Roman coins, fibulæ, were found in a stone pit in Hunstanton Park, Norfolk. Vid. Brands Jour^l.

Camden says “That the Romans were possessed of Devon appears from the Fossway crossing it, and from their coins dug up in it, particularly a gold Nero at Exeter another of Theodosius near Barnstaple. Several silver ones of Severus &c and brass coins in great quantities and from lares discovered a few years ago at Exeter.†

† [Gough's “Additions” to Camden's “Britannia” (1806), vol. i. p. 43. W. P.]

Fragments of rude sepul. urns pottery have been found in Wokey Hole Wilts, Zannloch, Franconia—

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[*Metal*]

Metallic Lumps resembling gold have been found in several stone chests with human bones in barrows situated in the centre of a Druidical temple, called Souden Hill in Cumberland. "Amulets, as preservatives against diseases, witchcraft, and other unforeseen accidents, were highly esteemed by the ancient Britons; and after death, were deposited in their sepulchres, or placed upon their ashes in urns as guardians of their manes."—9 vol. of *Archæologia* by Hayman Rooke Esqr.†

From its occurrence among decidedly Druidical reliques it is not improbable that the copper slag in question was applied as an amulet—it may have been contained in the urns—reliques of which lay near it.

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[144c]

Beetles

The Links of Skail in Sandwick one of the Orkneys abound in barrows—some are formed of earth alone, others of stone covered with earth. In the former was found a Coffin made of six flat stones—They are too short to receive a body at full length—The skeletons found in them lie with the knees pressed to the breast and the legs doubled along the thighs—a bag made of rushes has been found at the feet of some of these skeletons, containing the bones most probably of another of the family—In one were to be seen multitudes of small beetles; and as similar insects have been discovered in the bag which enclosed the sacred Ibis we may suppose that the Egyptians and the nation to whom these tumuli belonged, might have had the same superstition respecting them—(British and Lond. Ency. Arti. Barrow)

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[61a]

Roman Remains

At Watlington Park Oxfordshire at fifty or 60 feet depth many whole oaks, hazel-nuts—a stag's head and antlers were found and on the same spot two Roman urns (Dr Plotts His of Oxon)—

+ [*"Druidical and other British Remains in Cumberland," described by Hayman Rooke, Esq., F.A.S., in a letter to the Rev. Dr. Lort. Read Feb. 4, 1790. "Archæologica," vol. x. (not ix.) p. 109. W. P.]*

Ralph Brother of Earl Widdrington showed me many human bones taken from whole skeletons, with British beads, chains, iron rings and brass bits of Bridles dug up in a quarry at Blankney, Lincolnshire, which was probably plain mould when these old corpses of the Britons were interred: and I saw many human bones and armour with Roman coins, fibulæ &c, found in a stone pit in Hunstanton Park, Norfolk—

[52]

Occupation of British {Settlements} {Scites} by the Rom^a.

Sir R. Hoare remarks (P 107. Northⁿ District) that on some of the highest points of land (Bidcomb hill ex. gratia) the seats of the barbarous Briton or nomad are visible the traces of Roman occupation in painted walls of stucco, fragments of Hypocausts, tessellated pavements—convincing argument that this polished people either supplanted or associated with the rude possessors in their primitive and pastoral colonies—and my own experience had prior to reading Sir R Hoares work, satisfied me that they had followed them into their subterranean haunts—where they left unequivocal testimony of their presence in their arms earthenware and trinkets. (and the result of the investigations of the tumuli throughout the kingdom, when two distinct interments are visible?—the Roman disposed above the rude celt—that they likewise used their earthen sepulchres for their own dead, accommodating themselves to their customs while living and dead—Doubtful).

[53]

Invasion of the Belgæ

The Belgians a Teutonic race, it is conjectured, invaded Britain four or five cent. before the Christian era—From the Rhine they migrated into the Netherlands and spread over all that region of Gaul lying on the north of the Seine—and the Morini from Gessoriacum (Boulogne) and the Portus Iccius (Wissan) soon crossed the channel—and expelled the Celts successively from Kent, Hants, Wilts, Dorset, Somerset, Devon and Cornwall Sir R. H. 19. N. Wilts

Swarms from the same hive

Of their wild condition no better picture can be given than that by Tacitus of the Fenni. [Previously quoted.]

[54]

[The Morini] From Sir R. Hoare's An. Wilts. Vol. 1

The Morini came from Boulogne into Devon and settled

there—What Tacitus says of the Fenni will equally apply to the colonists of Devon—shewing an analogy in the habits of the primitive inhabitants of Britain and Germany.† [Previously quoted.]

[55]

[First Inhabitants of Britain]

According to the Triads (historical) published in the Archaeology of Wales—"the first inhabitants of Britain were of three correlative migrations, successively, from Gaul. The *Cymry* (Cumry) or Welsh came FIRST, seemingly to give place to the *Celtic*, (or German,) invaders of Gaul; and withdrew to the *west* side of England. . . . They came from Picardy and Flanders, and left there part of the tribe, whose resistance of the Celts was probably the occasion of their assuming the denominations of *Brythen*, (Bruthen) or Warriors. The SECOND migration was from a very numerous and extensive tribe of the same nation, (the Cynetes, commonly called Iberians,) which occupied the banks of the Loire, or *Ligar*, and those of the Rhone, whence they spread to Genoa, under the latinised name of Ligures The Welsh called them Lloegrwys, (pronounced Hloy-gruiss) and to this day called *England* LLOEGR, because it was chiefly colonized by that migration, whence the old Cornish descended. The THIRD migration was the chief part of the *Brythen*, . . . probably when the *Belgæ* wrested the north of Gaul from the Celts. The remainder submitted to the Belgæ, but continued distinct from them, about Boulogne, in the time of Pliny who calls them Britanni. They seem to have occupied all the lowlands of *Scotland*, till reduced by the *Caledonians* . . . who were Celts, that is, Germans, ancestors of the modern Scots."‡

[56]

[Valley of the Couse]

"In the lower extremity of the valley of the Couse, one of those descending from Mount Dor, a variety of fossil remains of mammalia were lately discovered including the mastodon, elephant, rhinoceros, hippopotamus, tapir, bear, ox, several species of deer, hyæna, panther, fox, and some others,"—the teeth of the bear belonged to *Ursus Cultridens*—derived

† ["South Wiltshire," p. 14, note. W.P.]

‡ [See Britton's "Beauties of England and Wales," vol. xxii.; "Wiltshire," pp. 711-2. W.P.]

from strata belonging to the freshwater formation of Auvergne, but it appears from Dr Buckland's examination of the site, "that the bones had been preserved in a bed consisting chiefly of siliceous sand interposed between two beds of quartzose gravel containing pebbles of primitive rocks, the whole being covered with a tufaceous conglomerate of volcanic gravel and sand, containing rolled fragments of pumice lava, basalt, quartz, mica-slate and granite, and fragments of fossil wood. All these beds derived from transported materials, lean against the east side of the hill called Boulade, composed of strata of fresh-water limestone, capped by basalt and based upon granite. On the south side of the Boulade between Pardines and Perrier, the thickness attained by this *diluvial matter* is no less than 300 feet, the whole being composed of alternations of materials similar to those above described, and containing similar bones." Quarterly Rev. Oct. 1827†

Scropes Geol of Central France‡

[57]

Denudation of Brambury and Hare Hills

These hills constituting the highest beds of the Brora district, afford upon their sides and summits distinct traces of a strong diluvial current which has swept them free of covering matter, depositing in the plain of Clyne Miltown a mass composed of the debris of the denuded hills, mixed with boulders of the coarse red conglomerate. A large portion of the turf having recently been removed, the surface of the rock is now seen to be scored with parallel lines precisely similar to those observed by Sir James Hall, Dr Buckland &c—And in this case altho the surface of the ground is very unequal, and the dip and bearings of the denuded strata vary considerably, the direction of the markings is uniformly from N.W. to S.E.

(Murchison's supplementary remarks on the Oolitic Series in Sutherland)§

[58]

(Date of Deluge)

[44c]

Cuvier says that "nature everywhere distinctly informs us

† ["Beauties of England and Wales," vol. xxxvi. p. 462. W.P.]

‡ [See "Memoir on the Geology of Central France." By G. Poulett Scrope, F.R.S., F.G.S., &c. 1827. Notes, pp. 18 and 29. W.P.]

§ [See "Supplementary Remarks on the Strata of the Oolitic Series, and the Rocks associated with them, in the Counties of Sutherland and Ross, and in the Hebrides." By Roderick Impey Murchison. Trans. Geol. Soc. London, 2nd Series, vol. ii. p. 357. 1827. W.P.]

that the commencement of the present order of things cannot be dated at a very remote period; and it is remarkable that mankind everywhere speaks the same language with nature."†

And again, "I am of opinion with M. De Luc and M. Dolomieu,—“That, if there is any circumstance thoroughly established in geology, it is that the crust of our globe has been subjected to a great and sudden revolution, the epoch of which cannot be dated much farther back than five or six thousand years ago; that this revolution had buried all the countries which were before inhabited by men and by the other animals that are now best known; that the same revolution had laid dry the bed of the last ocean which now forms all the countries at present inhabited; that the small number of individuals of men and other animals that escaped from the effects of that great revolution, have since propagated and spread over the lands then newly laid dry, and consequently, that the human race has only resumed a progressive state of improvement since that epoch, by forming established societies, raising monuments, collecting natural facts, and constructing systems of science and of learning.”‡

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[44e]

(Prior World)

“As far as it goes, the Mosaic account is in perfect harmony with the discoveries of modern science. If Geology goes further, and shews that the present system of this planet is built on the wreck and ruins of one more ancient, there is nothing in this inconsistent with the Mosaic declaration, that the whole material universe was created in the beginning by the Almighty: and though Moses confines the detail of his history to the preparation of this Globe for the reception of the human race, he does not deny the prior existence of another system of things, of which it was quite foreign to his purpose to make mention, as having no reference to the destiny or to the moral conduct of created man.”§ Inaugural Disc.

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(Continents of Ante and Post Diluvian World the Same)

It would appear from the little that is said in Scripture

† [Kerr's Cuvier's "Theory of the Earth," § 32, p. 146. W.P.]

‡ [Ibid. § 34, pp. 171-2. W.P.]

§ ["Vindiciæ Geologicæ. An Inaugural Lecture." By the Rev. William Buckland, B.D., F.R.S., M.G.S., &c. Oxford, 1820, pp. 24-6. W.P.]

that the ante Diluvian Continents were the same with the present: and a similar conclusion is to be derived from the universal dispersion of the bones of *land* animals in those superficial depositions of gravel, which seem to have resulted from the deluge, in almost every valley of the earth that has been mad[e] the subject of Geol. investigations. As these bones are remarkably perfect, and seldom have signs of having been much rolled, or transported from a distance, they appear to have belonged to animals that have lived and died near the spots where they are now found. Those places consequently must have formed parts not of the ocean of the antediluvian world, but of its continents.

"The highest point of Woodbury common, about eight miles south-east of Exeter, is evidently water-formed. Of this there can be no stronger proof than the immense quantities of rounded pebbles, and other water-worn stones, formerly composing a sea-beach, but now the summit of that high common."†

Polwhele—

Speaking of the neighbourhood of Moreton he says it "hath such disordered features as lead us to attribute the irregularity to some violent irruption of the waters. The vast fragments of stone scattered so extensively around us, or piled on one another in the rudest heaps, are clearly the remains of some terrible wreck. The hill that rises above the Logan-stone at Drewsteignton, shews every where, the boldest vestiges of an inundation. The appearance of the country about Hightorr rock, evidently marks a deluge. The hills are broken up, or strangely rounded. The rocks along the sides of the hills are smoothed by the waters, or shattered by the force of the torrents; whilst an infinite number of pebbles are dashed round these abrupt masses. The vallies have on one spot an even surface, but gravelly and sandy—on another, they are ploughed up into the wildest irregularities. All around, indeed, the very entrails of the earth are laid open. These were not common floods. They were such as might divulge the whole strata of the hills, wash away the substances that had been accumulating for ages, and bring others instantaneously into their place." Page 75, [76.] *ibid.*

† ["The History of Devonshire," in three vols. By the Rev. Richard Polwhele, 1793, vol. i., p. 76. W.P.]

[61]

fifth cent[ury]

Taliesin, the Prince of B[ritish] Bards thus announces himself—who commemorates the ancient rites of the Druids

I am Taliesin
Chief of the Bards of the West
I am acquainted with every sprig
In the cave of the arch diviner."

[62]

Again—

Deluge

Truly I was in the bark, with Dylan the son of the Sea
Embraced in the centre. Between the royal knees—
When the floods came, like the rushing of the hostile spirit
From Heaven, to the great deep—"†

Mr. Bryant, in 2^d vol of his Analysis‡ considers the mystic rites of the several nations as commemorative of the Deluge—"All the mysteries of the Heathen Nations seem to have been memorials of the Deluge—and of the events which immediately succeeded."|| The belief of the An. Britons in a deluge may be collected from the songs of the Bards and the Triads or metrical Triplets—and may be thus summed up. The profligacy of M.kind had provoked the G. Supreme—At this time the Patriarch distinguished for his integrity was shut up together with his select company in the inclosure with the strong door. Here the Just ones were safe from injury—The lake Llion burst his bounds: The waves of the sea lift themselves on high round the borders of Britain. The rain poured down from Heaven and water covered the earth—But that water was intended as a lustration to purify the polluted globe, to render it meet for the renewal of life and to wash away the contagion of its former inhabitants into the chasms of the deep abyss. The flood which swept from the surface of the earth the expiring remains of the Patriarchs contemporaries raised his vessel or inclosure on high from the ground, bore it safe upon the summit of the waves and proved to him and his associates the water of life and renovation." Mythology and rites of the British Druids Page 226

† [This passage is in pencil in the MS. W.P.]

‡ ["A New System of Analysis of Antient Mythology," 2 vols. 4to, in 1774, and a 3rd in 1776. W.P.]

|| [Ibid. vol. iii. p. 174, 3rd ed. 1806. W.P.]

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Welsh Triads on the Deluge

(Collected by Caradoc of Llangarvan about 12 cent and published by Thos. Jones of Tregaron in 1601—)

“The waters burst forth—all lands were covered—all mankind were drowned, except only two persons who escaped in a boat—of them was re-peopled the Island of Britain.” This catastrophe is numbered amongst the “awful events of the Island of Britain—The general events of early ages are consigned and appropriated to the Island of Britain as tho the inhabitants formed a branch of the Patriarchal stock on whom these events passed—Even the vessel that carried a male and female of all that lived was it seems too claimed as appertaining to the I. of Britain and regarded as one of its master-works. “The ship of *Nevydd Nav Neivion* which carried in it a male and female of all living when the lake of waters burst forth.” The learned author of the C. R [Celtic Researches] thus remarks on the above. “The personage who survived the deluge is called *Dwy-van* and his wife *Dwy-vach*—the Godlike man and woman. His name is *Nevydd Nâv Neivion*—the celestial one, the Lord of the waters. Our old bards call him *Dylan ail Mor*—*Dylan* or *Dyglan*—son of the sea from *Dy-glaniaw*, to land, or to come to shore—whence perhaps *Deucalion*—The same author seems to think that the actions of *Hu-Gadarn* the deified Head of the Druids recorded in the same Triads have reference to Noah—

1 His branching or elevated oxen (perhaps his offering) at the deluge drew the destroyer out of the water, so that the lake burst forth no more.

2 He instructed the primitive race in the cultivation of the Earth.

3 He first collected and disposed them into various tribes—

4 He first gave laws, traditions &c or adapted verse to memorials—

5 He first brought the *Cimri* into Britain and Gaul, because he would not have them possess lands by war and contention: but of right and in peace.” Page 165

It may not be uninteresting to the curious to have some account of the mystical allusions preserved in the few fragments of Bardic Rhymes or Triads—Metrical triplets and legendary traditions that have escaped to our time—They contain faint yet indisputable memorials of the early periods which their progenitors, the primordial colonists of Britain and Gaul may have witnessed and transmitted engraved upon

stones as an inheritance of awful interest—from father to son.

Helioarkite Superstition

The same author continues—But how are we to account for such a coincidence in the mythology of nations so widely separated? Perhaps it would not be an unreasonable supposition that the rudiments of those fanciful systems which prevailed over the Gentile world, whatever changes they may have afterwards undergone from local corruption and mutual intercourse were laid *before the* nations separated from the Patriarchal stock. How are we otherwise to account for the prevalence of the same fabulous relations and commemorative symbols in the East of Asia and amongst a sequestered people in the West of Europe? It is curious to observe in the old poems and tales of the Britons and in the ancient books of the Hindoos the same train of ideas. P. 227.

And again in P. 282. "The commemorations of the Deluge were so pointed and clear in the mystical rites of the Britons that when the Bards became acquainted with Scripture history they perceived and frequently alluded to the connection between their own national traditions and the sacred records respecting Noah and his family. Hence they considered their own as a genuine descendant of the Patriarchal religion and therefore as not absolutely irreconcilable with Christianity." He concludes the subject with this reflexion—I regard it as in connexion with the discoveries of Mr Bryant and Faber affording demonstration to the candid Philosopher that Heathenism had no foundation of its own to rest upon and that its tottering fabric merely leaned against the great Historical truths which are recorded in the sacred volume." P. 290.

He recapitulates an ingenious and curious disquisition on the allegorical poems and rites of the A. British—The Britons constantly interweave the memorials of the Deluge with their remotest traditions of the origin of the country and the nation whence arose an inference that this was the superstition of the *earliest* settlers in Britain and the degenerated offspring of the Patriarchal religion which our ancestors derived from the great stock of the Noachidæ. 493. (upon which was subsequently engrafted the alloy of Phenician error)

The general voice of mythology (which with Mr. Bryant and Faber the learned author interrogated and proved to be consistent with British traditions) to which I may now add that of the sequestered Britons admits that the personage who escaped in his bark from the great deluge was distinguished

from the mass of perishing mortals by a divine Providence and miraculously preserved on account of his piety and righteous^a. P. 500

"Docent multa (Cæs. lib 3. C. 2) nobilissimos gentis clam et din, vicens annis inspecu aut in abditis saltibus.

"With all this the celebration of the nightly mysteries, described in the chair of Taliesin. his Ogoo Gorddewin cave or spicus of the archdiviner, the torches of Ceridwen which flamed at midnight and at the dawn accord.

[64]

Bear—Modern

American B. 7 feet long from the extremity of the nose to the tail

"Wormius informs us," says Buffon, "that there are three kinds of Bear in Norway, the first is very large, not altogether black, but brownish, and not so destructive as the other kinds, living only on herbs and the leaves of trees: the second is smaller, blacker, and carnivorous, often attacking horses and other animals, especially in autumn: The third is still smaller, but fails not to be noxious; He is said to feed upon ants and delights in overturning their hillocks."†

"The brown Bear," says Buffon, is "furious and carnivorous."‡

The black Bear is rare in the Alps, but in N America and north of Eur abounds wild, frugivorous and uniformly refuses flesh—

[65]

Bear

The keen darting Gurnerth slew the largest Bear that ever [11] was seen with an arrow of straw—the ancient Britons ascribed peculiar virtues to the symbol of straw.

[66]

Bear

[44a]

Bear was killed in Scotland A.D. 1057—Hist. of Gordons I. 2—"In Cornwall and in Wales, several places still retain the name of *Pennarth* or *Bears-head*. Polwhele, 128 [vol. i.]

[67]

Bear

[39c]

"In the times of the Romans, and during a great part

† [Op. cit. pp. 435-6. W.P.]

‡ [Ibid. p. 435. W.P.]

perhaps, of the Saxon Heptarchy, when agriculture was still in its infancy, the wild boar, and the bear were not unknown to the Western Britons."—Polwhele—136. [vol. i. p. 135.]

[68]

Sus—Hog

Remains of the Hog have been found in this country in the cave of Hutton in the Mendips associated with Elep, Deer and Fox—they are now preserved in Mr Callcott's cabinet in the Bristol Library—The tusk is about 3 in long—it is fig in Plate xi of the *Reliquiæ Dil*—Fig 30—In the late excavation for the Topsham canal the under jaw of a Hog was also found in peat or alluvium—similar in its color and preservation to the remains of the Irish Elk—It is a size less than the tusk lying near the spear and other remains and which has every appearance of being fossil, measures by the curve 7 inch—tho it appears to have been broken at the base.

2 fragments of the jaw containing some teeth accompanied it—

2 {other} {more} fragments of jaws had been discovered by Dr Buckland and the Revd. L. P. Welland—both much inferior in size—Dr B specimen is fig in the Plate of the Deers remains. The teeth in both specimens are worn smooth—these in my collection are not at all.

[69]

[43c] *Hog Herd Submerged, like Irish Deer—*

Connected with the discovery of the remains of Hog in the cave may be noticed the following singular Relation taken from Polwhele's *His of Devon*—P. 74—

"An extraordinary discovery was lately made in a court-lage, upon a rising ground belonging to Chapel farm in the parish of Cruwys Morchard, near Tiverton. The house and estate was formerly a monastery belonging to the Augustine friars In order to convert a fine spring into a pond, to water the meadows below Mr Brooks (the proprietor) began to sink an extensive pond—When the workmen had sunk about ten feet from the surface, the strata appearing in its natural state, they came to a spongy matter, it appeared to be a very thick cuticle of a brown color, covered with hogs bristles; they soon found bits of bones, and lumps of solid fat of the same color. . . . it was then resolved cautiously to work round the carcase, when at last the complete body of a large hog

was found, reduced to the color and substance of an Egyptian mummy; the flesh was six inches thick and the hair upon the skin very long and elastic. As the workmen went on farther, a considerable number of hogs of various sizes were found in different positions; in some places two and three together, in other places singly, at a short distance. Upon the bodies being exposed in contact with the open air, they did not macerate or reduce to powder as is usually the case with the animal æconomy after lying two or three centuries divested of air This piggery continued to the depth of twelve feet, when the workmen stopped for the season. . . . The several strata being entire, renders it impossible to conjecture from what causes this extraordinary phenomena can be accounted for. The family of Cruwys (into whose hands the monastery fell at its dissolution) have a complete journal of remarkable events in the parish for three centuries, and not the least mention is made of any disorder which could occasion such a number of swine to be buried in such a situation; and the state of the strata leaves a great doubt, that they must have been placed there by some supernatural cause."† By another acc^t it appears that portions of the fat, skin and bristles are still preserved by the curious at Tiverton—The bones are softened to cartilaginous consistence—The whole being converted to spermaceti. Similar changes were observed to have taken place in Human bodies in the repositories of the dead in the Convent of Innocens, Paris—Vol 5—Annales ch Chymie and in Churchyards in this country.

[70]

[*Necks of Mammals*]

Necks of Carnivora shorter than those of the frugivorous and particularly of the Ruminant species. This difference in the length of the neck depends on the largeness of each vertebra—and not on their greater number—which is always the same from the Elept to the mole.

[71]

General Remarks—

Page 3 *Theory of E.* "And if they take any interest in examining, in the infancy of our species, the almost obliterated traces of so many nations that have become extinct, they will doubtless take a similar interest in collecting,

† [Polwhale's "Devonshire," vol. i. pp. 74-5, note. W.P.]

amidst the darkness which covers the infancy of the globe, the traces of those revolutions which took place anterior to the existence of all nations.

We admire the power by which the human mind has measured the motions of globes which nature seemed to have concealed for ever from our view. Genius and science have burst the limits of space, and a few observations, explained by just reasoning, have unveiled the mechanism of the universe. Would it not also be glorious for man to burst the limits of time, and, by a few observations, to ascertain the history of this world, and the series of events which preceded the birth of the human race?"†

[72]

[44e]

Wind up

Conclusion of Cuviers Theory of the Earth

"And man, to whom only a short space of time is allotted upon the earth would have the glory of restoring the history of thousands of ages which preceded the existence of his race, and of thousands of animals that never were contemporaneous with his species."‡

† [Kerr's Cuvier's "Theory of Earth," § 1, pp. 3, 4. W.P.]

‡ [Ibid." last par. W. P.]

[END OF FASCICULUS J.]

ON THE ALLEGED OCCURRENCE OF HIPPOPOTAMUS MAJOR AND MACHAIRODUS LATIDENS IN KENT'S CAVERN, TORQUAY.

BY W. PENGELLY, F.R.S., F.G.S., ETC.

It is well known to Palæontologists that, in his "History of British Fossil Mammals and Birds," published in 1846, Professor Owen mentions *Hippopotamus major* and *Machairodus latidens* as having been found in Kent's Hole.

Of the first he describes no specimen which the Cavern had yielded, and does no more than make the brief incidental remark that "Remains of the extinct Hippopotamus have been found in other limestone caves in England than at Kirkdale; as, for example, at Kent's Hole, Torquay" (p. 410). But of the Kent's Cavern Machairodus remains he gives a circumstantial description, with two figures of a canine and one of an incisor, both "discovered by the Rev. Mr. Mac Enery." (pp. 174-183.)

It is equally well known that the late Dr. Falconer was very sceptical respecting the value of the evidence in favour of either of these species. In fact he did not believe that they had been met with in Kent's Hole. With regard to Machairodus, his hypothesis was that Mr. Mac Enery had brought with him, or had obtained, from Italy some of its remains found in the Val d' Arno, that these had, in his collection, got mixed with the Kent's Hole fossils, and that he had incorrectly, though in perfect good faith, ascribed them to his favourite Cavern.

I purpose in this communication to give a brief summary of the evidence in each case, confining myself, of course, to discoveries which had been made prior to 1846—the year in which Professor Owen's work was published.

Before this date the only explorers of the Cavern (with the exception of a few gentlemen who occasionally accompanied Mr. Mac Enery, but who are not known to have written anything on the subject,) were Mr. Northmore, Mr. (now Sir)

W. C. Trevelyan, Mr. Mac Enery, Dr. Buckland, and Mr. Godwin-Austen. The only things, therefore, which can be regarded as evidence are:—1st. The actual statements of these gentlemen. 2nd. Their figures of the specimens they found. 3rd. The specimens themselves.

Mr. Northmore's discoveries are recorded in two "Letters" written for and printed in Blewitt's "Panorama of Torquay," in 1832; Sir Walter Trevelyan's are figured in a plate which Mr. Murray of Albemarle Street published in 1825; Mr. Mac Enery's in his "Cavern Researches," and in a series of 18 plates; Dr. Buckland's, in the Edinburgh Philosophical Journal, vol. xiv. pp. 363-4 (April 1826); and Mr. Godwin-Austen's in the Transactions of the Geological Society, second series, vol. vi. part 2, pp. 433-489.

Mr. Vivian published, in 1859, a compilation from Mr. Mac Enery's "Cavern Researches," illustrated with seventeen plates. Two additional plates, obviously belonging to the same series, have been recently discovered. Whilst lately transcribing the entire manuscript with a view to its publication, I found that it afforded conclusive evidence that the plates just spoken of were a part of the "thirty" mentioned by the author in his prospectus, and that it contained a large amount of valuable unpublished material on the subject now before us. Hence the present communication.

Of the specimens found in the Cavern by the explorers just named, the principal are, of course, those which formed the greater part of the late Mr. Mac Enery's collection, and which at the sale of his effects were scattered far and wide, though, doubtless, many of them found a place in the British Museum. Writers on British Cavern Mammalia frequently mention specimens lodged in the national and other collections, as having been found in Kent's Hole by the Rev. J. Mac Enery, and purchased at the sale of his collection. My belief is that *taken as isolated facts*, such specimens are utterly valueless as evidence in any doubtful case. Mr. Mac Enery explored not only Kent's Hole, but also the cavern at Ansty's Cove, the "Ash Hole" near Berry Head, and the Pixies' Hole at Chudleigh; and his collection was enriched from each and all of them, as well as from other and more distant sources. At the sale of his effects, which I attended and at which I purchased specimens, very few, if any, of the fossils were labelled. The mathematician may perhaps be able to give a rude approximation to the probability that a specimen purchased there was found in Kent's Hole, but unless it had written on it, in Mac Enery's hand writing, a statement

respecting its locality, there cannot be any *certainty* in the matter, independently of such as may be given by the description contained in the Palæontological portion of "Cavern Researches," no part of which has yet been given to the world.

Hippopotamus major:—On carefully perusing the writings and plates which have been enumerated, it will be found that Hippopotamus is mentioned by Mr. Northmore only, whose statement I cannot regard as of much weight; for, in the first place, he does not profess to have found himself any other remains than those of Hyæna, Bear, Wolf and Fox; nor does he say on whose authority he mentions the other forms. The following is his only statement on the subject:—"The organic remains discovered in this complicated Cavern are principally those of the *Rhinoceros*, *Hippopotamus*, *Elephant*, *Hyæna*, *Cavern-Bear*, *Elk*, *Tiger*, *Ox*, (and I believe *Buffalo*) *Horse*, *Wolf*, *Dog*, *Deer*, *Sheep*, *Rat*, *Mouse*, and some others."*

2ndly. There is no reason to suppose that he had more than a very superficial knowledge of Palæontology.

3rdly. His account was written fully seven years after his brief explorations had ceased, and, as he states, was "drawn up from some *hasty* memorandums, and * * * * very *imperfect* observations made at the time."† He adds that he had very few of his fossils remaining.‡

4thly. Mac Enery was obviously so very proud of the Cavern in which he had spent so much time and labour, and was so well acquainted with all that Northmore and every one else had done and found in it, that he would certainly not have been silent respecting Hippopotamus had it been met with there.

5thly. Dr. Buckland, to whom Mr. Northmore "immediately communicated his discovery,"§ thus describes the remains in Kent's Hole: "There are also *album gracæcum*, * * * * and stumps of gnawed horns of rhinoceroses, but no *horns of this animal*, although more than a hundred of its teeth have been already found; and also the teeth of many infant elephants;—numberless bones of horses, elks, deer, and oxen,—and gnawed bones and jaws of hyænas, with their single teeth and tusks; also the teeth and tusks of bears, tigers, wolves and foxes,—and of an unknown carnivorous animal, at least as large as a tiger; the genus of which has not yet

* Trans. Devon. Assoc. vol. ii. p. 485. 1868.

† Ibid. p. 480.

‡ Ibid. p. 484.

§ Ibid. p. 484.

been determined."* The fact that the *Hippopotamus* is not enumerated amongst the Kent's Hole mammals, even by him who, three years before, had described it as amongst those found in Kirkdale Cavern, must surely be regarded as full of significance.

In short, I cannot but come to the conclusion that there is no trustworthy evidence that *Hippopotamus major* has been found in the Torquay Cavern.

Machairodus latidens:—The case of *Machairodus* appears to belong to a very different category. Mr. Mac Enery asserts frequently that he found remains of this powerful carnivore in Kent's Hole, he describes in considerable detail the conditions under which it was found, and I cannot but believe that Dr. Buckland referred to it when, in the passage just quoted, and after having mentioned "tiger," he spoke of "*an unknown carnivorous animal at least as large as a tiger, the genus of which has not yet been determined.*" This passage was printed in April, 1826—about three months after the alleged discovery of *Machairodus*, as we shall presently see.

One of Mr. Mac Enery's plates, defined as "Plate F," contains seven figures representing, in the natural size, different aspects of three distinct canines of the animal now under consideration, which at that time was known and spoken of as *Ursus Cultridens*. The plate was delineated by "*Mary Buckland,*" lithographed by "*G. Scharf,*" and is labelled "*Teeth of Ursus Cultridens. Found in the Cave of Kent's Hole, near Torquay, Devon, by the Rev. Mr. McEnery, Jany. 1826, in diluvial Mud mix'd with Teeth and gnaw'd Bones of Rhinoceros, Elephant, Horse, Ox, Elk and Deer, with Teeth and Bones of Hyænas, Bears, Wolves, Foxes, &c.*" It is the only Plate in the entire series which contains a statement of the date on which the specimens were found, or of the animals with whose remains they were commingled. Mr. Mac Enery seems to have been fully aware that his discovery was important and, so far as Britain was concerned, unique; and thus, even in the Plate, he was circumstantial beyond his wont. It may be supposed, perhaps, that he anticipated scepticism, and lost no opportunity for furnishing the evidence which it demanded.

I now proceed to cite from his "Cavern Researches," published and unpublished, the passages in which he speaks of *Machairodus latidens* under the name, of course, of *Ursus Cultridens*.

* "Edin. Phil. Journ." vol. xiv. pp. 363-4 (April 1826).

When describing a part of the Cavern known as the Bear's Den, he says, "It is worthy of remark that the remains of *Ursus Cultridens* do not appear here no more than among the Bears in the German caves, though it does as we shall see in the other chambers with Elephants."*

When speaking of the Wolf's Cave," he remarks, "To enumerate the amount of fossils collected from this spot would be to give the inventory of half my collection—comprising all the genera and their species including the *Cultridens*, there were hoards."†

The foregoing are the only passages on this animal which occur in that part of the "Researches" which has been published.

In another description of the "Wolf's Cave," he says, "It is impossible without the suspicion of exaggerating to convey an idea of the enormous aggregation of remains including the new species of *Ursus Cultridens* in this retired branch, they were heaped in incredible quantities against the opposite foot of the cave—some fastened like stakes into the fissures and interstices from which it was impossible to dislodge them without taking them to pieces . . . other specimens bore marks of contusion as if occasioned by repeated blows against the sides—while others were literally shivered to pieces . . .

On the other hand many fine and delicate specimens among which was *Ursus Cultridens* were found quite uninjured in the midst of the shattered bones."‡

In what may be termed the Palæontographical portion of his "Researches," the following statement occurs:—

"*Ursus Cultridens*"

"Among the various productions of this prolific cave this species is most distinguished—for the peculiarity of its structure and its variety—until it made its appearance in this place it was altogether unknown to the naturalists of this country who at first view pronounced it to belong to the Saurian family from the serrated beading of its edges—and it was but little more known on the continent—2 fragments of anomalous species of Bear were found in Tuscany which Cuvier provisionally named as the Etruscan Bear—but the researches of Mr Pentland an English naturalist of great eminence led to the discovery of an entire head in the Museum of Florence

* Trans. Devon. Association, vol. iii. p. 240. 1869.

† Ibid. p. 243.

‡ Ibid. p. 294.

which had been raised from the bed of the Val d' Arno and determined the species of the Etruscan Bear—by degrees it began to reveal itself and an analogous tooth to those previously found in this cavern was discovered in the cave of Lunel near Montpellier. The resemblance of the tusk to a blade made Cuvier change the local name of Etruscan to the more general and characteristic appellation of *Cultridens*—Up to the present time it seems to be confined to the three localities specified in Italy, France and England—and with respect to the cave of Kents Hole it is scarce only five teeth having been found and those limited to those regions of it where the bones of the *Elep Rhin* are mixed up with those of carnivora—and it is curious that in that district of the Cave " (Bear's Den) "which was usurped by the species just enumerated" (Cave Bear) "as its exclusive Den, it has not discovered itself—thus intimating a difference of habit from its congeners—which a survey of its characters corroborates—It is rather singular too that in the German caves which swarm with Bears it has not been seen, nor in Chudleigh nor Austis Cove in Devon where the Bear predominates—but in the mixed assemblage of bones.

Its form is semilunar, compressed and tapering to a point like a blade—and along the course of the enamel which occupies nearly one half of its entire length and assumes a fine edge, it is delicately dentated—vid P. F Fig 1. 2. 3*—exhibiting different views of the most perfect tooth—

The curved fang was snapped off and the hollow of the tooth disclosed which with its unworn point shows it to have belonged to a young individual fig 1. 2. 3. The other teeth represented in the same plate are truncated at their apex, and despoiled of their posterior serrature while the anterior indenture is entire—How far this serrated and trenchant form throws light on the habits of the animal can be matter only of conjecture.

This tooth would seem therefore to have served rather as a weapon of assault or defence than for the purpose of cropping vegetables which its serrated aspect would indicate for in the latter process the internal face of the tooth would be rather worn than its point which would not have been brought into such use, or at least not violently broken as it appears in the aged specimens—The appearance of the blunted apex of the teeth bespeaks the effect of violence—the part is not worn down and polished as is the case with teeth employed in bruising vegetables but broken sharply off as if from the act of piercing its foe—But Cuvier infers from the smoothed sur-

* See Mr. Vivian's edition of "Cavern Researches."

face of the molars in the Etruscan specimens that this species lived on fruits—as well as flesh—

The enamel is longitudinally striated, and the base of the fang is distinguished from those of the other Bears by dotted lines in strong relief—

Judging from the wear of the apex and the solidity of the fangs, 3 of the specimens belonged to adult Individuals—They are all gnawed at their base—and the young one cracked across.

There is a tendency in the unworn canines of the Hyæna and Tiger to a denticulated edge—but it is very faint and is soon obliterated altogether—Those teeth likewise are of a quite different form—their enamel does not cover the one fourth of the tooth the body of which is likewise double its bulk and swelling—It approaches nearest the herbivorous reptile armed with serrated grinders brought to light from Tilgate forest by Mr. Mantell and which he has designated the *Iguanodon*—

In addition to the canines I have lately discovered in the same bed a small tooth about an inch long—the internal face of the enamel is fringed with a serrated border—this tooth is distinguished further by two tubercles or protuberances at the base of the enamel from which the serration springs and describes a pointed arch on the internal surface—Vid fig 8. 9.* the body of the tooth in this specimen is not compressed but rounded. whether this belongs to an inferior species of *U. Cultridens* or simply the Incisor anterior to the canine of the large species of *U. C.* I am not able to pronounce with certainty. If merely the incisor, it is still interesting as it serves to show that the serrated character is not confined to the canines and that the rest of the teeth and consequently the frame are marked by a peculiar conformation.”†

After some remarks of a speculative character, the author thus commences his

“Inferences from Cultridens”

“That it lived in the vicinity of the place where it is interred cannot be an instant doubted—removal in the medium of the loam would have been necessarily attended

* These figures do not occur in any plate belonging to the series published by Mr. Vivian in his edition of “*Cavern Researches*,” but amongst several plates recently presented to the Torquay Natural History Society, by Mr. Gardner, who obtained them from the late Mr. C. Kilby, Mr. Mac Enery's executor, there is one containing five figures, of which three are no doubt different views of the “incisor” here described by the author. The only words on the plate are “*I Scharf del 1837.*”

† *Trans. Devon. Assoc.* vol. iii. pp. 368–70. 1869.

with the fracture or rounding of its delicate and fragile blade. The occurrence of this curious species among numerous remains of various ruminants and carnivora unfolds a complete analogy between the former population of this country and of the warmer climates of Italy and France—and that those countries were so constituted that” [they were] “habitable by the respective inhabitants of the torrid and frigid zones.”* He then proceeds to show that *Ursus cultridens* is an extinct species, and that its extirpation was caused not by “a partial agent operating on an insulated district, but an universal and contemporaneous movement attended with similar effects in Italy and France.”†

When speaking of the scarcity of feline remains in the cavern, the author remarks that they are “next to the *U. Cultridens* the scarcest.”‡

When describing the “Character and Condition of the Fossils,” he says:—“Several specimens belonged to the young of the different animals. All bones with their epiphyses yet unconsolidated, but still adhering—and jaws or rather mere membranous shells enclosing the rudiments” [of] “second sets of teeth advancing beneath the milk ones which themselves are still standing * * * * and which with the least removal or violence would have fallen out.

“Such likewise are the delicately-edged and compressed teeth of the *Ursus Cultridens*.”||

Such, then, is the evidence in favour of the proposition that remains of the animal now known as *Machairodus latidens* were found in Kent's Hole. Briefly it is as follows :—We are informed by Mr. Mac Enery, whose labours have for ever associated his name with the Cavern, that, in January 1826, five canines of this mammal were found in what he termed the Wolf's Cave; that they were mixed with remains of Rhinoceros, Elephant, Horse, Ox, Elk, Deer, Hyæna, Bear, Wolf and Fox; that, whilst some of the commingled fossils were contused, and others were literally shattered to pieces, many fine and delicate specimens, including the canines spoken of, were quite uninjured; that the canines were figured in a plate defined as Plate F, which plate is well known to palæontologists; that, at a later period, he found in the same bed a tooth which he believed to be an incisor of the same species; that no trace of this mammal had been found in the “Bear's Den;” and that its remains were scarcer than those of any other of the cavern animals.

* Trans. Devon. Assoc. vol. iii. p. 371.

† Ibid. p. 421.

‡ Ibid. pp. 371-2.

|| Ibid. pp. 456-7.

It is difficult to perceive in what respect this evidence is defective, and it may be concluded that had the world been in possession of it, there never would have been any scepticism on the question.

Not only does it prove the occurrence of *Machairodus* in Kent's Hole, but probably furnishes the date requisite for the identification or the rejection of the specimens in various Museums in England, which are said to have been found in the Cavern.

The following statement respecting the specimens just alluded to has been compiled from a description of them by the late Dr. Falconer:—There are only five teeth of *Machairodus* of reputed British origin. Of these, three were found by Mr. Mac Enery in Kent's Hole, and were sold at the sale of his effects; when two of them were purchased by the late Dr. Lovell Phillips, and the other by Dr. Battersby, probably for Lord Enniskillen.* Of the five, one was presented by Mrs. Cazalet to the Museum of the Geological Society of London, on February 16, 1826; one to the Museum, Oxford, by Dr. Lovell Phillips; one to the British Museum, by Dr. Lovell Phillips, one to the Museum of the Royal College of Surgeons, London, by Lord Enniskillen; and one was purchased by Mr. Koenig for the British Museum, at the sale of Mr. Mac Enery's effects. The first four are reputed to be from Kent's Hole, and the fifth is said to be of British origin.†

Dr. Falconer remarks of the last that "its mineral condition is certainly not that of Kent's Hole; it is dark and discoloured as if from the Val d'Arno." Mr. Boyd Dawkins accepts the first four as genuine Kent's Hole specimens, but makes no mention of the fifth.‡

Assuming, for the present, that the five canines mentioned

* In a letter, dated July 29, 1869, Dr. Battersby was so good as to send me the following statement:—"There was a card sold at Mr. Mac Enery's sale with three teeth (serrated on each side) and marked *Ursus Cultridens*. These were purchased jointly by Dr. Phillips and myself. After the sale was over Mr. König of the British Museum came to me and said he had been particularly anxious to have bought them, but had not observed they were on the card until after it was knocked down. Dr. Phillips and I then agreed to give him one for the Museum. Dr. Phillips sent his to the Museum at Oxford, where I believe it now is. The third I forwarded to Lord Enniskillen with a number of other teeth, &c. I had purchased for him, and what has since become of it I do not know."

† See "Note on the Remains of *Depranodon* or *Machairodus* of Reputed British origin," in "Palaeontological Memoirs and Notes of the late Hugh Falconer, A.M., M.D." Compiled and edited by Charles Murchison, M.D., F.R.S., 1868, vol. ii. pp. 459-61.

‡ *Quart. Journ. Geol. Soc.* vol. xxv. p. 204. 1869.

by Mac Enery are all that the cavern has hitherto yielded, that the first four spoken of by Dr. Falconer were really from the cavern, and that the fifth was obtained elsewhere, there obviously remains one, and only one to be traced.

Upwards of two years ago, Mr. Vivian and I had the pleasure of meeting Sir Walter C. Trevelyan in Kent's Hole, of which, as has been mentioned, he was one of the earliest explorers. The principal topic of our conversation was the scepticism respecting Machairodus, when Sir Walter stated that he did not entertain the least doubt on the question, that he was well acquainted with the discovery at the time it was made, that one of the canines was given to him and was still in his possession. These statements I repeated in a discussion which arose on the question, in the Geological Section of the British Association, at Dundee, in 1867; and when preparing the present paper, I wrote to Sir Walter requesting to be favoured with the exact particulars.

In his prompt reply, he stated that he was at Torquay in 1826 about the end of February and beginning of March; that on the last day of February he spent some hours excavating in the cavern; that he did not see the tooth found; that it was given him by Mrs. Cazalet, he thinks, and not by Mr. Mac Enery; that in their several collections he saw, he believes, all the specimens that had been then discovered; and that the specimen given him is still in his collection.

If, then, only five canines were found in the Cavern, we can now account for all of them.

But is it safe to assume that no more than five were exhumed? Did Mr. Mac Enery include, in the five he mentioned, the two which passed through Mrs. Cazalet's hands? In his "Researches," he gives a list of the somewhat numerous persons who occasionally accompanied him to the cavern, and he mentions some who made independent investigations there; but in neither of the lists does Mrs. Cazalet's name occur. He does not certainly profess to have himself found all the five: his words are "only five teeth having been found."

After a careful consideration of the evidence, I decidedly incline to the opinion that Mrs. Cazalet's two were included in Mr. Mac Enery's five, that all the specimens were found by him, and that the total number was five only. True, he does not introduce Mrs. Cazalet's name; but it is also true that he does not mention the name of any lady, though he alludes to one who appears to have been interested in the Natural History of the district and to whom he gave a cavern fossil. Thus, when speaking of a "loose heap of red

marl," he says, "In this loose heap it was that I found the first Rhinoceros tooth, which I presented to a lady at Torquay who had a collection of objects of natural history from the environs—I had not yet commenced my own collection."* I am informed by persons who resided at Torquay at the time and knew Mr. Mac Enery very intimately, that he was on the most friendly terms with Mrs. Cazalet, who was his co-religionist; and as we know from other sources that she had a collection of the cavern fossils, it may be safely inferred that he was well acquainted with all the specimens in it.

Readers of his "Cavern Researches" are aware that it was Mr. Mac Enery's wont to mention all specimens of interest met with in the Cavern, whether by others or by himself; thus he speaks of choice fossils found by Rev. L. Welland, Rev. F. Belfield, Mr. Henry Maxwell and others; hence, it may be concluded that Mrs. Cazalet's specimens were not overlooked by him, and that as the credit of finding was not assigned to any one by name, they were found by himself and presented to the lady.†

In short, when we remember that, as he stated in a passage already quoted, Mr. Mac Enery did not at first begin to form a collection, and that before he did so he gave a specimen to a lady; that, as he states elsewhere, he commenced his "digging at the close of 1825;"‡ that, according to "Plate F," the canines of *Machairodus* were found in January 1826; that Sir Walter Trevelyan saw, in February of the latter year, a collection of the Cavern fossils, including *Machairodus*, in the possession of Mrs. Cazalet—a lady of congenial tastes with whom Mr. Mac Enery was on the most friendly terms; that no mention is made in "Cavern Researches" of any one besides the author having met with *Machairodus*, whilst he frequently speaks of the discovery of other fossils by other investigators; we are apparently warranted in drawing the following conclusions:—

1st. That Mac Enery alone found canines of *Machairodus* in Kent's Hole.

2nd. That the total number of specimens found was five.

3rd. That he gave two of them to Mrs. Cazalet soon after their discovery.

To these we may add the following:—

* Trans. Devon. Assoc. vol. iii. p. 236. 1869.

† There is in his Manuscript a memorandum respecting the number of the flint implements found in the Cavern and the persons in whose possession they were. In the list "Mrs. C." (probably Mrs. Cazalet) is credited with six. (Trans. Devon. Assoc. vol. iii. p. 458.)

‡ Ibid. p. 414.

4th. That the remaining three were purchased at the sale of his effects.

5th. That at present one of the five is in the British Museum, one is in the Museum of the Royal College of Surgeons, one in the Museum of the Geological Society, one in the Museum at Oxford, and one in the collection of Sir Walter C. Trevelyan.*

* POSTSCRIPT.—During the meeting of the British Association at Exeter, after this paper had been read, Mr. E. Ray Lankester showed me a canine of *Machairodus* which had been found in the Forest Bed of Norfolk. (See *Geol. Mag.* vol. vi. pp. 440-1. 1869.)

NOTES ON THE PRE-HISTORIC ARCHÆOLOGY OF EAST DEVON.

PART II.

BY REV. R. KIRWAN, M.A., RECTOR OF GITTISHAM.

IN a memoir of the excavation of three tumuli at Broad Down, which has appeared in the printed Transactions of this Association, I called attention to the fact of the abundance of these sepulchral memorials in the eastern division of this county. Further research has proved them to be even more numerous than I had at first supposed to be the case. Some fifty of them comprise the group, of which Broad Down may be described as the head-quarters. From a careful examination of these barrows, I am disposed to believe that the larger members of the group, some of which are about 100 feet in diameter, and attain a perpendicular height at the centre of the mound of ten or twelve feet, are stone tumuli or cairns. These are the result of great labour, and probably they are not to be accounted for from mere local peculiarities furnishing the requisite supply of loose stones. The oldest historical book* that we have informs us of the practice that prevailed among the Jewish people of raising heaps of stones over the dead as a mark of detestation and indignity. The contents, however, of the stone barrows at Broad Down prove that they had a different purpose. They must have ranked among the most distinguished honours awarded to the illustrious dead, and have occupied the labour of months, and have required the united exertions of large bodies of work people in order to gather together the materials, and pile them up into such durable monuments.

Another arrangement is also deserving of mention, where a group of seven barrows occurs in the immediate neighbourhood of those visited by the Association last year, and

* 1 Joshua vii. 26; 2 Sam. xviii. 17.

which form a continuous chain running due north and south, and separated from one another by regular intervening spaces of about thirty feet. The central barrow of this group, and which is the largest, was formerly surrounded by a single row of stones closely set together, and forming a regular circle around the base of the mound. Whatever appears to indicate design in the form and arrangement of these primitive structures is worthy of note. If we can trace the motive by which those who raised them were actuated, we gain some clue to the condition and civilization of the race. Our attention to these minor details may also afford the means of classification in reference to the era or people, and may assist us in establishing a relative chronological arrangement of them on a satisfactory basis.

The existence of these memorials to the illustrious dead is not, however, confined to the neighbourhood of Broad Down. At Buckerell Knapp (about two miles west of Honiton) there occurs a group of five barrows, which are of even larger dimensions than are any at Broad Down; and at Combe Raleigh, about three miles north of Honiton, a single barrow of gigantic size stands alone. An attempt was made a few years ago to cut a trench through the centre of it, but the work was abandoned in despair.

My attention has lately been called to the existence of a group of barrows at Thorverton, about six miles north of Exeter; and through the kindness of Archdeacon Freeman, I have been enabled to undertake the excavation of one of them. The site of these barrows commands an extensive and varied prospect. On the southern side lies the range of the Haldon Hills; in the far west the granite tors of Dartmoor are distinguishable; whilst on the north there is a beautiful and interesting contrast of fertile slopes and dreary moor, amidst which peers up the antient hill-fortress of Cadbury. Of the tumuli occupying this favoured position, we selected the largest for examination. In general form and appearance it agreed closely with those with which we are familiar at Broad Down, being circular or sub-conical, six feet in perpendicular height at the centre, and about eighty feet in diameter. The mound was constructed of earth brought from a distance, and, apparently, the surface of the ground immediately surrounding the chosen site had been pared away and heaped upon the mound, so as thereby to add to its height. We commenced the excavation by driving a gallery from the south side towards the centre, and immediately upon removing the surface soil we came upon abundant traces of black

mould, ashes, and charcoal, the usual accompaniments of cremation. However, we reached the centre of the mound, and removed the superincumbent earth down as far as the natural surface without discovering any calcined bones, or specimens of mortuary pottery. We then enlarged our excavations, until we had entirely removed the earth which formed the centre of the mound, such as would be contained within a circle of about eight feet in diameter; but although the subsoil and different points within the central area were carefully examined, the labour was devoid of any practical result. The absence of any interment would perhaps imply that the mound was a mere cenotaph, although the abundant traces of the action of fire observable in the progress of excavation would tend to a contrary opinion. Probably the interment itself, and even the pottery that may have been associated with it, had been destructively affected by atmospheric influences, or by the extreme wetness of the surrounding soil. The penetration of the roots of the heath, furze, and peat, into and around the calcined human remains, affects them injuriously, and ultimately leads to their entire disintegration and absorption. By the same agency the pottery becomes filled with peat fibre, which causes fissures and displacements; and after the lapse of so many centuries, the material of which they are composed, being imperfectly baked and possessing but little cohesion, relapses into its original unctuousness.

We now proceeded with the remainder of the tumulus, and continued the excavation of the mound in a northern direction, when we came upon an interesting and eloquent memorial of the simple arts of the remote era when the mound was raised. This was a hammer-stone, doubtless one of the rude implements of the occupant of the barrow, and probably one of the tools with which his arrow-heads and other weapons of flint were fashioned into shape. The example before us appears to be simply a pebble, the rounded contour and smooth surface of which have been produced by long rolling either upon the sea-beach, or down the course of a river; for it bears no trace of artificial polish. It was probably selected by its owner for the particular purpose intended, both on account of its almost symmetrical shape, and also because, when the finger and thumb are placed in the orifices of the perforation, the shape of the stone naturally adapts itself to the hand. The material of the stone I take to be a cherty flint; it is semi-translucent, and of a pale amber colour. The perforation which existed originally in

the stone, and which is due to natural causes, appears to have been enlarged by working on the two sides of the stone with an instrument to which a semi-rotating motion was given, and which acted as a kind of drill; for the perforation opens out wide on the two surfaces, and is narrower towards the middle. In circumference the stone measures seven inches in a direction parallel with its longer axis, whilst transversely it measures five inches, and weighs about half a pound. At either extremity it is very much bruised and abraded, and presents such an appearance as would be produced if it were used, as I have suggested, for the purpose of striking blows or knocks on some hard brittle stone.

S. Nillson describes and figures several varieties of stone-hammers which the aborigines of Scandinavia* made use of to chip out their flint instruments, and some of which resemble in a remarkable degree the example before us.

He says: "The marks of blows found on them were, as must be evident to every one not totally ignorant of the subject, occasioned by blows on some hard brittle *stone*, not against any kind of metal. Similar chipping stones are found from the pole to the equator—among all nations who use stone implements. . . . On all of them we find at the edges marks of the purpose to which they were formerly applied so unmistakable, that, when once pointed out, no further doubts can be entertained on the matter. I am of opinion that all hammer-stones, without exception, were portable, and that the savage was in the habit of carrying them with him while hunting. For this purpose some of them have a groove or furrow running along the outline, round which, probably, a string was passed, by means of which the stone was tied to the belt; others are, for the same purpose, pierced through; and others again, without either groove or hole through the centre, were probably carried in a pouch attached to the belt or otherwise. . . . Amongst this latter or portable hammer-stones we class those which are provided with two or more round indentations, in order that they may be held more securely between the fingers while being used. If we examine a stone more minutely, it is scarcely possible to mistake the purpose for which it was used. We see on its edges the most distinct traces of blows against some other hard stone, while the sides are perfectly smooth and untouched. This is so evident that it cannot escape our notice when we have once perceived it. We find some hammer-stones which have only one indentation on each side; these

* "The Primitive Inhabitants of Scandinavia," pp. 10-13.

are partly oval. We also find others provided with several indentations, and of these some are nearly spherical, or of a round cubical form, with six indentations; others are of an oblong cubical form. All these tools are made of hard and heavy stones, and to all of them the savage has, by chipping, sharpening, and drilling, given the form which he considered to be most suitable."

M. Lartet describes and figures a hammer-stone found in the caves of Perigord at La Madelaine, and which nearly resembles the example before us.

Thus, then, the excavation of the Thorverton barrow gathers interest, not only from the fact of its having yielded the only example of an implement to be referred to the stone age that has yet been discovered in East Devon, but also because it affords us at the same time an unfailing index of primitive arts, and an instance of a defined progress in civilization. However true be the words of the preacher in the sense in which he uttered them, yet we may find "device, and knowledge, and wisdom, in the grave;"* that is, in the grave-mounds of the antient people, the records of whose history we are endeavouring to trace out. The very fact of the existence of these memorial heaps, indestructible except by violence, is an eloquent one in the evidence it furnishes, that in the dim and long-forgotten past, of which we are seeking to recover the history, man was still the same, of like passions with ourselves, violent in his anger, and no less demonstrative in unavailing sorrow.

During the past winter a find of coins occurred at Cotley Farm, near Axminster. A labouring man, in removing an old hedge-row, came upon a hoard of some forty or fifty silver coins, uninscribed, of which but five are now to be found. The rude type to which these coins are to be referred at once proves their antiquity; they belong to a class usually found in Dorset and Wilts, though never before (so far as I can learn) found in either of the Western Counties, and were probably struck not long prior to the Roman occupation of this country. Their average weight is about fifty grains. Gold and copper coins of nearly the same type are occasionally found with the extremely degenerate head of Apollo on the obverse, and the disintegrated horse on the reverse.

Some writers have even gone the length of denying the existence of any *British* coinage at all. It seems, however, now to be generally admitted by numismatists that a British coinage did once exist, and of this we appear to have a proof

* Eccles. ix. 10.

in the examples before us. We know that there was a native coinage in Gaul long before the days of Julius Cæsar, and we also know that at the same period traders were in the constant habit of passing from one country to the other; indeed, Cæsar mentions that the coast of Britain was inhabited by colonies which had passed over from Belgic Gaul, and it may be inferred that the state of civilization in his time would not be materially different among the people who dwelt upon the two sides of the Channel.

The coins before us appear to be rude and degenerate imitations of the *STATER* of Philip of Macedon—the *regale numisma* of Horace. The types of this coin—the Philippus—are, on the obverse, the laureate head of Apollo, and on the reverse a charioter in a *biga*, with the name of Philip beneath. The earliest Gaulish imitations follow the prototype pretty closely; but in the course of time both the head and the *biga* become so transformed that almost all resemblance of the original is lost. Now if, as was probably the case, the Britons derived their knowledge of the art of coining from the Gauls, we may expect to find an imitation more or less rude of the types of the Macedonian Philippus; and the greater or less resemblance of the coins to the prototype may afford a means of approximating to the date.

The examples before us appear to have attained to the extreme of degeneracy; we shall probably, therefore, not greatly err if we attribute them (as I have said) to a period not long anterior to the time of the Roman occupation. On the obverse appears but a small portion of the laureate bust, whilst on the reverse the horse has entirely disappeared. There are numerous pellets in the field, and in one of the examples the space beneath appears to have been ornamented with lines.

THE LIMITS OF PHILOSOPHICAL INQUIRY.

BY THE REV. J. ERSKINE RISK, M.A.

THIS subject is one which I venture to hope will be discussed on general rather than special grounds. It will appear manifest as we proceed that the presence or absence of limits to inquiry in the domain of philosophy must be determined more by a view of the nature of man's faculties than by a survey of their subject, or, as some now prefer to say, object-matter. It will, of course, at once be understood that we are not now called upon to examine into the capabilities of physical science; for vast and truly wonderful as have been its past triumphs, the laws of vision must necessarily draw the boundary-line at a point appreciable indeed by the powers of human arithmetic, if not quite by that of human conception. The very terms of the question show that we have only to deal with the capabilities of intellectual science.

Setting aside then all question as to the amount of knowledge it is possible to attain with respect to things bounded in themselves, though even as regards these the amount of knowledge must depend on the capabilities of the individual inquirer, the great point of philosophical curiosity has always been to discover what information is there obtainable by man with regard to things in themselves unbounded, and therefore inappreciable by sense. The grand inquiry of philosophy is thus:—Is a philosophy of the Infinite, the Absolute, the Unconditional, possible? In other words, Can philosophy embrace a theory of Being, abstracted from all limits, all relations, all conditions of any kind to which the terms "limits" or "relations" do not apply? The thought which strikes me here is one which I feel convinced will also strike any mind not sophisticated by previous theories or prepossessions on the subject. It is this: Granting even that such a philosophy has been constructed, of what possible use would

it be, regarded in a practical point of view? It avowedly deals with an abstract something, obtained by the successive removal of everything phenomenal which can identify it with real existence to us; and were it even possible, some have fancied, that a special intuition of the higher faculty they call the Practical Reason should obtain a direct view of this abstraction, I cannot but think that the infinite thus disclosed would bear about as much relation to the true Infinite which Deity embodies, and alone comprehends, as the abstract man of Plato's definition—"the two-legged animal without feathers," so well travestied by the exhibition of a plucked cock in the middle of Plato's lecture—would bear to the genuine specimens of our race we see amongst us. I throw this out, however, as a thought *en passant*, which we may have occasion afterwards to test when arrived at a further stage of this discussion.

Having premised thus much, let me enumerate the leading opinions which according to Sir William Hamilton have been entertained on the subject. 1. "The unconditioned is incognizable and unconceivable, its notion being only negative of the conditioned, which last can alone be positively known or conceived." This is Sir William's own opinion. 2. (Held by Kant) "It is not an object of knowledge; but its notion as a regulative principle of the mind itself is more than a mere negation of the conditioned." 3. (That of Schelling) "It is cognizable, but not conceivable; it can be known by sinking back into identity with the absolute; but is incomprehensible by consciousness and reflection, which are only of the relative and different." Here, as Sir William H. adds, "the intuition itself, reason, and the absolute, are identical. The absolute exists only as known by reason, and reason knows only as being itself the absolute. This act is necessarily *ineffable*. 'The vision and the faculty divine' to be known must be experienced. It cannot be conceived by the understanding, because beyond its sphere; it cannot be described, because its essence is identity, and all description supposes discrimination." Schelling candidly allows that those who cannot rise above a philosophy of reflection must feel the doctrine of the absolute to "appear only as a series of contradictions." "An absorption into the absolute," which is nothing short of pantheism, is the only way by which, according to Schelling, any knowledge of the absolute is obtainable. Well might Sir William H. pronounce that this annihilation of subject and object of consciousness, in order to arrive at "an arbitrary abstraction," is but to grasp at "nothing, hypostatize the zero thus attained, give it the name of absolute, and imagine that we contemplate

absolute existences, when we only speculate absolute privation." No wonder then that, on the one hand, Hegel, one distinguished follower of Schelling, had at length to admit the intuition of *pure* or *undetermined* existence to be identical with *nothing*, while Oken, another and as celebrated disciple, did not hesitate to "identify the absolute with zero."

The fourth opinion is that of Victor Cousin. He thinks that "the unconditioned is cognizable and conceivable by consciousness and reflection under relation, difference, and plurality." Of Cousin's opinion I need scarcely remark, that what he terms the absolute would by Schelling, from the very definition which he gives of it, be identified only with the relative and phenomenal. This is plain, because Cousin maintains that the unconditioned can be known *under the conditions* of consciousness; viz., relation, difference, plurality; while Schelling, on the contrary, fancies that an intuition of existence beyond "the bounds of space and time" is possible. Cousin, of course, would pronounce of Schelling's opinion, that as he removes this intuition from the sphere of such peculiarities as must distinguish the human individual, or in point of fact any finite being, this knowledge of the absolute can be nothing but the negation of thought itself.* Thus, as has been well observed, each of these philosophers, while agreeing in thinking that the absolute is known, would "regard as the climax of absurdity and contradiction the manner in which the other endeavours to bring the human reason and the absolute into proportion." The whole problem involved is the same as that so long ago proposed in the query of Orpheus—Ὡς δὲ μοι ἐν τῇ τὰ παντὶ ἔσται, καὶ χωρὶς ἑαυτοῦ; "How shall the all be the One, while each shall still be separate?"

Having now enumerated and explained the leading schools of thought which have existed on this subject, I think we may at this point be in a better position to estimate the four canons proposed by Mansel in his celebrated Bampton Lectures, for testing the reality of knowledge professed to be derived from consciousness. These have been briefly enunciated as follows: "There must be an object about which to think, distinguishable from other objects. 2. There must be a person who thinks, distinguishable from the object about which he thinks. 3. There must be a time to think in, of a certain limited duration, as a portion of the life of the thinker, which must succeed or precede other portions of

* Schelling's own expressions too would give some plausibility to the assertion. In one passage he remarks: "We awaken from the intellectual intuition as from the state of death—we awaken through reflexion."

time in which he is thinking of other objects. 4. Attributes of body must be conceived as existing in space, and attributes of mind as existing in person." These limits, which may be briefly summed up as postulating the necessity of distinguishing, for the sake of clear thought or knowledge, the object thought of, the person thinking, the time to think in, and the precise place as to space or personality in which the objects of thought inhere, are, you perceive, narrow enough, and yet not more narrow, we may at first be inclined to think, than must necessarily be the case with creatures of bounded faculties. There have been, however, certain thinkers who, as we have already seen in our survey, are disposed to question this, and to believe in the existence of transcendental faculties—faculties, that is to say, which pass the bounds of time and sense.

Let us, therefore, see how Mansel applies these canons to the determination of the points at issue. And here I must premise that the whole of Mansel's treatment of this part of the question has been by some critics stigmatized as "a piece of jugglery with logical terms," or as "a confounding of terms with realities." Upon a close review of what Dean Mansel has advanced, I am myself disposed to think there is a certain degree of injustice in these strictures; while I must at the same time admit that it requires a very close scrutiny, both of his statements and of the object he had in view in making them, to avoid falling into a similar misconception. It would, I dare say, have occurred to most persons, on a cursory first perusal of the Bampton Lectures, that Mansel intended to meet his opponents on the ground they themselves occupied. It might thus have been supposed, as has indeed proved to be the case at least in one instance (that of a writer in the *The Christian Observer*), that he adopted "the absolute and infinite, as defined after the leaders of German metaphysics," as "a synonym for the true and living God." Mansel, however, in the fourth edition of his work declares his object to be precisely the reverse. He asserts that the absolute and infinite, both of the German metaphysics, and of all other metaphysics with which he is acquainted, is a notion which destroys itself by its own contradictions. He believes also, to use his own words still further, that God is, in some manner incomprehensible by him, both absolute and infinite, and that these attributes exist in Him without any repugnance or contradiction at all. Hence he declares and maintains throughout, "that the infinite of philosophy is not the true infinite." In this, one of the latest expositions

which Mansel has given of the bearing of his views, I think we have the touchstone, before so much called for, by which we may test his application of the four canons already specified. So far from "confounding terms with realities," his object was to show that the terms thus used had no connexion with realities, but only concerned certain abstractions of the school or German metaphysics. He wished to show that the abstractions denoted by these terms had nothing to do with the true Infinite—an object, he conceives, above human thought and comprehension; and in order the more clearly to prove this, he sets an inexorable logic to work to demonstrate that knowledge beyond certain limits is impossible; while the attempt to pass these boundaries by the help of these abstractions would but involve us in inextricable contradictions.

Bearing this then in mind, let us now proceed to witness the way in which he tests the so-called philosophy of the Infinite. His first canon, you will remember, was the necessity for distinguishing *the* object of thought from all others. An object, he lays down, can only be known, in consciousness, for what it is by being distinguished from what it is not. And now comes the assertion which has laid him open to the charge of confounding terms with things, or of juggling with logical terms. "Distinction," he adds, "is necessarily limitation." Why? you may ask. "Because, if you distinguish, the object distinguished must possess some form of existence which the other has not, or not possess what the other has." The Infinite, therefore, cannot be distinguished from the finite by the *absence* of any quality; for such absence would be limitation. Nor can it be distinguished by the *presence* of what the finite has not; for the difference would thus itself be infinite, and have at the same time nothing in common with the finite. The second infinite (the distinguishing characteristic) would in this case too be distinguished from the finite by the absence of qualities which the finite possesses; while such a distinction again is, in Mansel's view, a limitation. He therefore thinks "a consciousness of the Infinite involves a self-contradiction; viz., the recognition by relation and difference of what can only be given as unlimited and indifferent." Nay, more, to make these contradictions more apparent, Mansel goes even further. He maintains that, if we conceive of the Infinite at all, we must "conceive it as potentially everything and actually nothing." Surely, you will say, this caps the former paradox all to nothing. But how is it to be proved? Thus—"If there be anything in general

which it cannot become, it is thereby limited; and if there is anything in *particular* which it actually is, it is *thereby excluded from being any other thing*." And again, as if all this were not enough by way of contradictions—"It must also be conceived as actually everything and potentially nothing; for an unrealized potentiality is likewise a limitation." But my hearers have now, I dare say, had enough of all the contradictions which Mansel evolved, perchance, for the amusement of some, from the philosophical abstractions and terms denoting them, with which alone we, now that we have been better instructed, know that he all along intended to deal. Had we been borne out in the supposition which would doubtless have first been naturally entertained, that Mansel was arguing from philosophic terms to sober realities, we might find reason to take exception to the statement, that the distinction of a term was equivalent to the limitation of the realities denoted by it.

But the explanations I have quoted are quite sufficient to set our minds at ease on this point. Mansel's argument as to the bounds of our knowledge is entirely of the nature of a *reductio ad absurdum*. To effect this purpose, what galled opponents may call juggling with the terms of philosophy is quite requisite. They indeed fancy that the terms they employ in their philosophy denote things, but Mansel is quite of a different opinion. He believes them to denote mere philosophical abstractions, and to show their want of vitality he gives you logical proof of their self-contradictions to human reason. To man's limited view a distinction in the terms he employs for things implies a limitation; for he knows not how to distinguish without, as he thinks, limiting. Were we speaking of the true Infinite, we should of course admit that what may appear to us to be limitation may to the Almighty be no limitation at all. But this is not the point at issue. We are supposed here to be dealing with those who maintain that we *can* know the infinite in itself, and that the philosophical terms in general use correctly represent it. Mansel, therefore, is in the right to contend with his opponents on the platform which they themselves have raised. I do not say that I agree with all of his conclusions, but I think that the general bearing of the whole argument, as an *argumentum ad hominem*, is just. If, therefore, he can make out that the knowledge of the philosophical infinite is a tissue of contradictions, he has carried his point so far—and that was to show that there are certain bounds which even the mightiest intellect cannot pass. When, accordingly, Mansel

has to apply his laws of human consciousness to such abstractions as the philosophic infinite and absolute, or as Sir William Hamilton would define them, the unconditionally unlimited and the unconditionally limited, he is quite justifiable in fighting such logical fictions with the logical paradoxes they involve "in the very terms in which," as he says, "the infinite" (it would have prevented much mistake to have said the philosophical infinite) "is expressed." His opponents believe these terms to embody an actual truth; he does not, and therefore he may show *such* contradictions to result from the meaning of the terms *as to* prove that there can be nothing real corresponding to them in *rerum Naturæ*. His object, you observe, is to make it evident that the true Infinite belongs to the horizon of faith, not to the domain of knowledge; and so the logical fiction must be put out of court as soon as possible. It is only therefore by considering his remarks to apply to abstractions, and not to realities, that we can accept his reasoning that a distinction of terms necessarily implies a limitation of the things which they denote. We must not conclude that things in themselves are necessarily bound by the limitations under which we are compelled to view them; for no one can soberly imagine that the universe is gauged to suit the greater or smaller capabilities of various beholders, for this would be but to reassert with the old philosopher Protagoras, that the mind is the measure of all things. The case is widely different, with abstractions of however extended a scope. Being really only creations of the intellect they are bound by the laws of the intellect, and by its laws they must be tried. If, however, they are ambitiously made to shadow forth thoughts of which the human mind is quite incapable, this will at once appear from their want of consistency, if pushed to their due logical conclusions. This, I apprehend, is Mansel's way of proving their unreality. Will it not serve to confirm us in this our understanding of his views, and our recognition of the explanation which he has fully given of them, if we remember further his definitions (in Lecture iii. page 46) of the respective tenets of the theist, pantheist, and atheist on the subject of the Infinite. "The theist," he says, "admits the co-existence of the Infinite and finite as *distinct realities*; the pantheist denies the real existence of the finite, and the atheist that of the Infinite." We cannot but conclude then, that when Mansel, as a theist, would thus allow "the co-existence of the finite and Infinite as distinct realities," he must allow also the connexion between the Infinite and finite

as regards the true Infinite, while asserting the co-existence of the limited and unlimited in the philosophical abstraction to be a self-contradiction. The reason obviously is, he is able to pronounce upon the contradictions or consistencies involved in an idea which is the creation of his own brain; while, as regards the inconsistencies or otherwise of the true finite with the true Infinite, he can come to no other conclusion than that the undeniable fact of their co-existence is the best, because the only attainable, proof, it would now appear, of their real consistency.

But further, it is instructive to remark, that as Mansel, by his second canon as to the necessary relation of the subject and object, denies our knowledge of the abstract absolute, which is an absence of all relation, except, perhaps, that of completeness, and by his third canon, of the necessity of consciousness under succession in time, denies the possibility of conceiving creation, as also the counter possibility of conceiving of none at all,* by his fourth condition of consciousness; viz., personality with the limitations and relations it implies, he proves that no idea of the divine personality can be obtained from the mere revelations of reason; for reason would reveal personality as "a relation between the consciousness and the modes of his consciousness," since "*in abstract thought* there is no personality without a thinker, nor a thinker without some mode of thought." Reason would also reveal personality as a limitation; for thought and thinker are distinguished from and limit each other, and in like manner the modes of thought are distinguished from each other by limitation." He proves this thus:—If I am *any one* of my thoughts, I live and die every moment. If I am *not* any one of my thoughts, this limits me too by *that* difference, and each thought, likewise, is limited by its difference. Hence it is that, on the one side, philosophical theologians err, and, on the other, pantheists, by seeking to explain what is inexplicable by mere reason; and so the former annihilate the divine personality by maintaining that in God there is no distinction between the subject of consciousness and its modes or object, or between one mode of thought and another, while the pantheist cuts the knot by maintaining that "God, as infinite and absolute,

* To conceive of creation, or even of no creation, you must place yourself in imagination at the beginning of succession in time, and therefore be conscious of the relation between a phenomenon in time and reality out of time. The mind therefore must be in time and out of it at the same moment! So writes Mansell.

can have neither intelligence nor will." Thus, you perceive, that both with their very different objects in view show—the one, by explaining away the divine consciousness, and the other by boldly denying all divine intelligence and will—that the God of their conception is a mere abstraction, and no person at all. I have given you the whole course of reasoning of Mansel on this point, in order still further to make evident the point which I wish to prove; viz., what the real object of Mansel was in this apparent juggling with logical terms. It is now, I think, tolerably clear that he pushes to their utmost limit the conclusions which may be drawn from the term person as contrasted with infinity, in order to show that the combination of the two notions is one which can never be made by reason, but must be authoritatively declared by revelation. Thus, as he so impressively adds, "we dishonour God more by identifying him with the feeble and negative impotence of thought, which we are pleased to style the infinite, than by remaining content with the limits imposed upon us." "Personality," he remarks, "though far from exhibiting the absolute nature of God as he is, is yet truer, grander, more elevating, more religious than those *vague, barren, meaningless abstractions in which men babble about nothing under the name of the infinite.*"

This last passage is, I beg you to remark, in itself quite sufficient to justify me in my view of all Mansel's arguments as simple reductions *ad absurdum* of any systems philosophical or otherwise which may be raised on mere abstractions. If men *will* build on such an insecure foundation, they must expect to see it crumbling beneath their feet, when undermined by an inexorable logic. But if the superstructure is thus compelled to fall, it is but that a fairer and sounder one may be raised in its room; one in which the information of knowledge is employed, so far as it can be expected to reach, but where also the temple of philosophy is completed and crowned most fittingly with the keystone of faith. Before leaving this part of the subject, however, I must enter my protest against any arguments for or against, taken from what we may fancy to be implied in the idea of personality. I do this for the simple reason that while all have an instinctive belief in it, few can so far impose on themselves as to attempt a definition of the constituent elements of the principle of individuality. This is something, I take it, beyond definitions, and this is another reason why I am disposed to think that Mansel pushes so far the contradictions involved in the logical definition in order to show it to be a

mere abstraction, a subtle creation of the brain, and therefore beset with all the contradictions which a definition drawn from deficient, and still more from erroneous, information, must possess. The phantom therefore which Mansel is continually fighting must be a logical creation of the abstract reason, which, on being subjected to a strict logical analysis, decomposes and dissolves into the thin air of an incongruous assortment of self-contradictions.* This is manifestly the case with Mansel's whole theory of contradictions which he has borrowed, after Sir W. Hamilton, from the antinomies of reason of Kant. His whole theory would fall in a moment, did we suppose him to be actually inferring contradictions in things themselves from the imperfect information inseparable from our own present state, and not from the logical abstractions which the pride of human reason has founded on that very limited information. The general doctrine, however, which he and Sir W. Hamilton seem to hold in common is one which admits of question, if this distinction between realities and abstractions be not observed. If, by asserting that all our knowledge lies between two contradictions, they intend anything more than to reduce to their inherent absurdity the conclusions which logicians may presume to deduce as to the constitution of the Infinite from our present imperfect grounds of information, the severe treatment which the doctrine has met with is assuredly deserved. Thus a slashing critic of Sir W. Hamilton's lectures in *Blackwood's Magazine*, (Oct. 1859, pp. 514-15) not regarding the statement in the light in which I have put it, pronounces the doctrine to be "a most fallacious statement," and more than insinuates that the asserted contradictions are "the product of a logical dexterity taking advantage of the undeniable obscurity of the subject." This critic declares that he "had never much respect for these ingenious antagonisms or antinomies of the reason," and in this feeling I confess I should sympathise with him, if I found the deductions of the human reason presuming to define the hidden secrets of divine realities. But again, he remarks, Sir W. Hamilton himself tells us "we have no positive conception of infinite space; we always think of a circle perpetually enlarging, having a *without* and *within*. This illimitable beyond is only infinite and is equally intelligible whether the circle is three feet in diameter, or whether it embraces all the known stars. But after having taught us this (he proceeds), it is mere sophistry to say that the opposite proposition of a bounded space is equally valid, because we

* See Mansel, p. 97.

cannot in a positive manner represent to ourselves the unbounded."

Here, indeed, in the last statement reviewed by the critic, it would seem at first sight as though Sir W. Hamilton were really applying his principle of the antagonisms of reason to existing realities. But a closer inspection shows this not to be the case; for though space in itself is an existing reality—still the attribute of infinity predicated of it is, in Sir W. Hamilton's view, if not in Cousin's, a mere abstraction, conceived only, as he himself pronounces, by a thinking away or abstraction of the very conditions under which thought is realized, and consequently it is a mere negative of the conceivable itself. (*Edinburgh Review*, vol. l. p. 203.) Mansel too confirms us in this view of the position which he and his great teacher ever wished to maintain. In his (4th) edition he clearly explains it thus in the new preface (p. xxx): "We cannot avoid in our present condition the contradictions and confusions which accompany every attempt to conceive the infinite. Yet we know enough to warrant the belief that these apparent anomalies are but the result of our own limits of thought, and may not be assumed as inherent in the objects which we attempt to conceive."

We have now, I think, arrived at a stage of the discussion at which I may profitably repeat my opening question: If our ideas of the infinite and absolute be thus admittedly mere abstractions, of what practical use can they be to us? Sir William Hamilton and Mansel both appear to return answers to this question, and the discussion is at once simplified by calling on them for a reply. Sir William Hamilton utilises the infinite and absolute, which he describes as "only the names of two counter imbecilities of the human mind" in this way. He will have it that they are "transmuted into properties of the nature of things," solely by the conversion of two subjective negations into objective affirmations."

Similarly Mansel, to meet a like objection, quotes with approbation the sentiment of "one of the ablest of his critics" in the *British Quarterly* (lix. p. 221): "It is preposterous to say that a negative notion is a notion of nothing. Far from it. It is a notion of something which we know only as *not* possessing qualities or suffering conditions which we see in something else with which we are familiar,—of such notions a considerable *part of our knowledge consists*." The same writer gives as instances "cold," and "death," and triumphantly concludes with the question, "Are these notions of nothing?"

The answer, then, which we have elicited from Hamilton

and Mansel appears just to come to this. These abstractions—which Hamilton sometimes calls “names only,” and at other times tells us, “that if attempted to be fixed as positives in knowledge they run through, like the water into sieves of the Danaides, as negatives into the abyss of nothing” (*Edinburgh Review*, vol. 1. p. 207)—these very abstractions have still some relation, even though negative, to the realities actually existing. This relation, it seems, is sufficient to convince us of their existence, though that in itself may be too great for human comprehension. A negative notion thus, according to the opinion approved by Mansel, is not a notion of nothing, but as real as our notions of cold or death; while Hamilton actually believes in the power of the mind to convert its counter imbecilities—the infinite and the absolute—or the equal impossibility of conceiving of any limit or no limit,—into the properties of the nature of things. It is not very consolatory to reflect that this practical solution of the question has led at least one writer to consider “the whole of the dispute on the subject of the infinite to be purely verbal.” Sir W. Hamilton, he says, agrees that the infinite exists; Cousin agrees that the infinite cannot be realized in imagination. The controversy turns on the meaning of the word “*idea*.” There would seem to be something in this suggestion; for if we understand by “*idea*” a sensible idea or idea of imagination, Hamilton would, of course, deny that we have any but a negative one, while he excludes himself from accepting the word in any other sense by his “view of Kant’s deduction of the categories of the understanding, and the ideas of the speculative reason, as the work of a great but perverse ingenuity.” He therefore describes the Kantian idea (“*Idee*”) to be but the conception (“*Begriff*”) sublimated into the inconceivable, reason to be only the understanding which has overleaped itself. Admit then with Leibnitz that “there is something in the intellect which was not in the sense,” and the idea, in the sense of necessary conception of the reason, may be inferred from the necessary existence of the infinite, which Hamilton himself admits.

You will understand me to give the account of this attempt at reconciliation of opposing parties without the expression of any opinion on my part just at this stage of the discussion, and so I pass at once to the distinction established by Mansel between speculative and regulative truth. By the former he seems to mean such truths as correctly represent the realities with which they deal; while by the latter he understands such a representation of the truths above us as our limited

faculties permit us to receive in a manner calculated to influence our actions and beliefs, but not to give us the full information, which even if given would be unintelligible. It is thus, as he repeats, adopting the words of a reviewer (p. xxix), to prevent misconception, "knowledge positive and trustworthy as far as it goes." Though incomplete, it is not therefore incorrect.

This view of the truths which govern action—being regulative, not speculative—goes far to answer the question which has been proposed, as to whether Mansel intends to hold that regulative truths can be in any sense abstractions. That they are realities revealed to the eye of faith, not of knowledge, so far as they can be apprehended by faith and not comprehended by reason, is manifest from the description he adopts of the knowledge gained thus through faith as being "positive," while he has all along maintained our knowledge of transcendental abstractions to be "negative." Nor is this the only reason we have to believe this to be Mansel's view. The conclusion is set on an irrefragable basis by his commendation of Taylor's statement, that "throughout the scriptures *the first truth* in theology is conveyed in terms of the moral system, never in those of abstract thought."

This then is quite sufficient to show that regulative truths can have nothing to do with abstractions; it remains only to show that he held a similar view as to the truths he terms speculative. It seems plain enough that Dean Mansel's opponents in argument fancy that their representations of the infinite find a counterpart in the nature of things, or more properly, Being itself. But it is just as clear that Mansel does not agree with them in holding this opinion; the account which he gives of it is quite decisive on this point. He calls their "Infinite" that pretentious perversion of the finite which philosophy dignifies with the name of infinite. Remembering this, and also what we have already cited from him as to "the vague meaningless abstractions of philosophy," we cannot but conclude that *he* would only dignify with the name of speculative truths those which would accurately correspond to the great mystery of being—a mystery which every thing seems to show is locked up from us, and, not unreasonably. It is only the Maker who can be justly expected to know His own nature and His own work! It has indeed been objected with some show of force, "how can we speak of that becoming a potency in faith which is an impotence in thought?" in other words the theory of Sir William Hamilton has been questioned which has been stated already,

viz., that an imbecility of thought can be in any way transmuted into a property of the nature of things. But the difficulty is only apparent; an impotence of thought only forbids us to discover how a thing is (τι ἔστι), or "the mode of existence," and so what it is: the conception of its nature in a word is excluded. While faith or belief is possible in the mere fact of its existence; τὸ ἔστι—faith therefore if real in any sense must be a potence in one way or another; we must believe that a thing is, or that it is *not*. Nor let it be maintained in reply to this that conception and faith must be the same—they can only be supposed to be so, by taking them to imply a mere assertion of a fact, and not as is really the case, to import, in the one case, that the existence of the fact is believed in, while in the other the mode of its being is accurately conceived. Regarded thus, the distinction is as simple as it is obvious. To conclude, as regards our cognition of really speculative truths, I need only make this remark. The belief which some hold in regard to their power of intuition is one which cannot touch us practically in any general reasonings on the subject. If any such intuitions there be, they must be peculiar to the individual, and as all seem to admit, incapable of transference or even of description to any other person.

It occurs to me that it is open to question whether Mansel's four conditions of consciousness would recognize the validity of knowledge so gained. But our limits narrow; and ere closing I must say something on the subject of physical laws. It is usual to say that the course of this world is ordered by the establishment of certain arrangements termed laws, by which "the periodical occurrence of its phenomena is determined." And so the universe, on its creation, is compared to a machine so skilfully contrived, that, once made, it need no longer require any special interference from its Maker.

Now the question, I consider, just comes to this at last. If philosophers are so inclined to reject the theory of the possibility of special interpositions with man and nature, as merely a human notion of the infinite and unchangeable, how can they be assured that it is any less human an account of the Supreme to say that His works are bound "by an immutable order in time," so that, His work once done, He has withdrawn into the mysterious recesses of eternity? The fact, on the contrary, is that which follows from the premises already admitted and established. The notions of unbroken succession in time, and of an arbitrary interference with it by

special interposition, are equally human and imperfect. Still, speculatively imperfect as each representation must be of the exercise of infinite power, they are both regulatively necessary, and, as Mansel remarks, may both have their prototype (and counterpart) in the ineffable being of God. But the truth is, that the whole theory of the government of the universe by laws inflexible and unchangeable rests upon a fundamental error.

Such a theory seems to build altogether upon "material principles," and to ignore the indisputable fact of the existence of a potent influence exercised by mind upon matter. In matter all seems an unending series "of mutual dependence;" in mind there is discoverable "an originating and self-determining source of power." That something in mind called will, "the agent," as Mansel so well describes it, "uncompelled yet not uninfluenced, whose continuous existence and productive energy are summed up in the word myself," is an element which, as it must be felt in the little world around us,—so we cannot but acknowledge that the sphere of its influence, when residing in the Infinite, must be such as to set all calculations at defiance, and to take laws from nothing short of its own Almighty purposes.

Thus it appears at last that the so much vaunted discovery of modern science—namely, the inseparable connexion of cause and effect, with the necessary succession of the one to the other, is one which can hold true only in *pari materia*, i. e., when both members of the succession are of the same kind, and even then the rule can only be proved universally true of a physical succession. Where, however, scientific researches have only approximated to, without precisely reaching a systematic and therefore orderly recurrence of phenomena; viz., the moment we pass from the world of matter into that of mind, we become sensible of the presence of new distracting elements connected with the individual volitions, which are so variable and fluctuating as to defy calculation, and baffle all attempts to reduce them to a system. No theory of character ever yet laid down could do more than estimate the bias of any mind. The decision by any mind, however well we have studied it, in any given case, on any point at issue, must always remain a matter of probability, not of certainty. The corollary to all this is obvious. If one finite mind cannot reduce to order the workings of a mind precisely like itself, the operations of the Infinite mind, transcending as it does the *human* conditions of time and space, cannot in all cases be known, but are only open to investigation in

certain cases where their impress has been left upon the world of matter in the form of certain orderly arrangements.

A fixed law of succession, therefore, is one which can only be established in the case of matter; and so long as mind is excluded from the computation, contingency is inconceivable. But once admit mind with its inherent will, and there is no saying where a break may not occur in the continuity, and a link be superseded from the succession, provided only that the mind and will in the case supposed be strong enough.

Such then, to wind up, are the conclusions to which a just estimate of the extent of man's faculties is calculated to lead us. Such as his faculties are, such also must be his knowledge. We have seen that the attempt to transcend the faculties, conditioned in time and space which God has given us, is one which must necessarily end in defeat.

In transcending the present conditions of thought we pass at a bound the limits of consciousness, and find the result of the flight, if really ever made, to be something undefinable in human language, were it even realizable in human thought. Nor is this all. We have also made the unpleasant discovery that even could the true Infinite be known by a higher and truly practical reason, the flimsy abstractions of philosophy are only likely to mislead us in the search by their *ignis fatuus* light. What then remains? Nothing but to know ourselves to be but men—not self-idolizing gods—to follow reason as far as she will lead us, and where she fails to hear the voice of the true God on the things above us, and solely of His sphere, the tidings of which we receive from messengers well tested and approved by reason. Thus, by giving to reason what is hers, and to the Infinite what justly belongs to it, we may see there are laws which reason's plummet never sounded, determined only by the will of the Supreme!

ON THE ORIGIN AND APPROPRIATION OF STONEHENGE.

BY REV. R. KIRWAN, M.A., RECTOR OF GITTISHAM.

IN the investigations of the Archæologist, even when confined within a limited range, or devoted to a single pre-historic memorial, he constantly finds that he is dealing with the evidences of certain phases of progressive civilization in the history of the human race. If he proceeds from the consideration of the antient monuments with which he is familiar at home, to those that occur in other parts of the globe, he will learn that there has been an epoch in the early history of man when a megalithic taste, characteristic of a primitive era, manifested itself under the utmost variety of circumstances. Rude memorial stones, of which the associations of venerable tradition have perished with their rearers, still survive in all parts of the world, as the enduring literature of an unlettered people.

When we enquire into the worship of nations in the most remote periods to which we have access, we find that the first object of idolatry was a simple unwrought stone placed in the ground as an emblem probably of the re-creative powers of nature. In all parts of India these stones are to be found, and are known by the name of "Linghams." There are many of them of immense size, and generally they stand near some magnificent temple. It is said that there is no instance of any of the antient heathen temples being found without them. It is probable that most of these stones were themselves the first objects of adoration, and that the temples were built near them as being places of peculiar sanctity. The Tyrians had two similar stones set up near Tyre, and probably the pillars of Hercules were stones of this description, set up by the Phœnicians. Amongst the Greeks similar stones (*stelæ* or *lithoi*) were to be seen in the neighbourhood

of many of their cities, and one is mentioned as occurring within the walls of Athens. The megalithic circle is an example of the same remarkable phase of the human mind, the influence of which has long since disappeared, although there was an era in the early history of man when it appears to have manifested itself almost universally. Throughout the whole of the Asiatic Continent this megalithic period of art at one time prevailed. In North and South America, amongst nations separated from the old world by oceans which had been regarded as impassable until the days of Columbus, we can point to enduring evidences of the same stage of development of the human intellect. In Norway, Sweden, Denmark, and Brittany, there occur many remarkable remains of this peculiar class; whilst in our own island, and close to our own homes—upon Dartmoor—the stone circles, cromlechs, and other interesting memorials of primitive antiquity afford abundant evidence of the same psychological phenomenon. And yet amidst this profusion of megalithic memorials, that of Stonehenge has a distinct and peculiar character, and is in some respects unique. Many of the stones of the outer circle have been hewn and squared by art, whilst the impost have been attached to the upright props upon which they rest by mortises and tenons fitted one to the other with the utmost nicety. In this respect, I believe, Stonehenge differs from all other monuments or memorials with which it has been compared, and gathers around it additional interest from the fact of its being the oldest existing example of the result of man's skill as a tool-making and tool-using animal.

I have said that these primeval memorials have outlived the traditions of their builders, whilst no hieroglyphic carved upon their surface furnishes us with a clue to their long-forgotten origin or purpose. And yet we are not to regard them as altogether silent and meaningless memorials of an older generation. We can furnish a probable answer to the question "What mean ye by these stones?" It is worthy of remark that remains of the class under consideration are frequently alluded to in the Old Testament. The history of the Jewish people proves that the rude monolith may preserve the memory of the event which it was intended to commemorate, and be faithful to the purpose for which it was set up. The oldest written notice of the monolith is that raised by Jacob after his dream: "Jacob rose up early in the morning, and took the stone he had put for his pillow, and set it up for a pillar, and poured oil upon the top of it." (Gen. xxviii. 18.) Again we read,

“Joshua took a great stone and set it up there under an oak that was by the sanctuary of the Lord. And Joshua said unto all the people, Behold, this stone shall be a witness unto us, for it hath heard all the words of the Lord which He spake unto us; it shall be therefore a witness unto you lest ye deny your God.”* I observe that Dr. Parkhurst supports the notion that the Jews followed the prevailing custom of setting up in a circular form the stones which they used in their religious rites. It is written in Exod. xxiv. 4, “Moses rose up early in the morning and builded an altar under the hill, and twelve pillars, according to the twelve tribes of Israel.” Here the stones are evidently twelve in number, in addition to the altar stone. Other instances of twelve pillars of unhewn stones being set up, and also of an altar at the same time, occur in Deut. xxvii. 2; and Joshua iv. 9, 19, 20. The question arises as to whether these twelve stones were arranged in a circle. Dr. Parkhurst states that the name “Gilgal,” given to the place where Joshua set up these stones, means a roundish heap of stones, or stone circle. We may therefore infer that the religious station of the Jews at Gilgal, and also the antient temple on Mount Gerizim, were circles of large stones resembling the so-called Druidical monuments of our own country. These examples may fairly be cited, as tending to prove that Stonehenge and other similar megalithic monuments were not sepulchral in their character, but were rather temples in which the worshippers sought to satisfy the human mind in its yearning after a shrine adequate to the mysteries shadowed forth in its primitive mythology.

I am aware that some of the earlier antiquaries have arrived at a different conclusion, and have argued that Stonehenge at least is sepulchral because of the large number of barrows that cluster round it. The inference, however, that this was its primary purpose is very imperfectly sustained by such evidence. If the argument be worth anything, it would prove that Salisbury Cathedral, being surrounded by graves, had also a sepulchral origin. The entire absence of a central cist or chamber, or of any other evidence of an interment within the *sanctum sanctorum* of Stonehenge, proves that it was not raised as a royal mausoleum or cemetery of a tribe. The accompanying barrows being circular are to be referred to the “Bronze Age,” a period long subsequent to that which saw the upraising of the huge megaliths before us, and of which the builders were separated from the occu-

* See also Joshua iv. 5; Judges ix. 5; 1 Sam. vi. 14, 15; vii. 12; 2 Sam. xx. 8.

pants of the barrows not more rudely by time than by dissimilarity of habits and ideas. A people indicated by the primitive arts and sepulchral rites of the circular barrows, would naturally choose the neighbourhood of such a monolithic group as Stonehenge for interment, regarding it in their day as a time-hallowed memorial of antiquity; it seems indeed to be an axiom of natural religion, that a spot once set apart for sacred purposes should be regarded ever afterwards as consecrated ground; the practices of modern savage tribes amply illustrates the same tendency. The Red Indians bury their dead in the huge mounds that occur in the valley of the Mississippi, and thus convert into a necropolis the sacred soil which originally had not been devoted to sepulchral uses. The barrows, therefore, that occur so abundantly in the neighbourhood of Stonehenge, I infer to be characteristic of an era subsequent to that of its erection, and the practice of the ritual to which it was consecrated.

Assuming the correctness of this inference, we recur to the question with which we set out. What was the primary purpose and appropriation of Stonehenge? Time would fail me if I were to attempt even to enumerate the many learned dissertations that the mystery enshrouding these monoliths has drawn forth; and under no circumstances have antiquaries theorised more recklessly. A whole literature has sprung up, commencing with the visit of Inigo Jones to Stonehenge by order of King James I., and from that time Charlton, Bishop Gibson, Wood, Cook, Smith, Dean, Higgins, Stukeley, and last, though not least, Sir R. Colt Hoare have raised theories on purely conjectural grounds. It would be wearisome to follow out the ingenious fancies to which the imaginations of these writers gave rise; suffice it to say that they generally concur in ascribing the erection of Stonehenge "to the Druids, the priests of the nation who were its sacred architects." The Druidical theory is based upon a passage in Pliny's Natural History, in which he relates the formation of an *Anguinum* or serpent's egg by an assemblage of snakes on a certain day; and he adds, "the egg was considered a potent charm by the Druids." It is on this slender basis that the Druidical origin of all our megalithic memorials has been based and their Dracontine character considered as established. If, however, we have recourse to the simple expedient of substituting investigation for theory, and follow the clue that recent research has placed in our hands, we may attain to some knowledge at least of the origin and use of the remarkable remains of this peculiar class. It

is unreasonable to expect that we shall ever succeed in decyphering from the dislocated masses of ruins left to us all the religious traditions that were once associated with them; but if we look for the key to the enigma to the same form of worship or superstition still prevalent, we may be enabled to trace the peculiar character of these monuments to a religion which, within the historic period, has exercised a general influence on the human race. It is a remarkable circumstance that, within the last few years, temples have been discovered in India bearing a close structural analogy to Stonehenge, and which were dedicated to that form of idol-worship known as ophiolatrea, or the worship of the serpent. It seems now to be regarded as established by the researches of Mr. Fergusson that the worship of the serpent first originated in India. He maintains that the country is now, and has been in all historical times, inhabited by two perfectly distinct and separate races of men. One, aboriginal so far as is known, of a Turanian stock, who worshipped trees and serpents, who built with a natural instinct as bees in a hive, and being possessed of an inborn taste for form and colour, they raised megalithic monuments wherever they went. About 2000 or 3000 years B.C., an Aryan race came into India; probably they had wandered from the cold and bleak regions in the immediate neighbourhood of the Caucasus, to the warm and genial lands that border on the Southern Tropic; they gradually spread over the country, and as being a superior race, perhaps possessing a knowledge of the use of metals, they dominated over their predecessors, the rude aboriginal Turanian tribes. Speaking broadly, these Aryan hordes were not artistic; they did not build, nor raise temples or monoliths, nor carve sculptures, but devoted their energies rather to the cultivation of literature; so that, whilst the literature of India—the Sanscrit—is Aryan, the architecture is Turanian.

I have mentioned that the Turanians were Ophites or worshippers of the serpent, and here we have probably a key that may serve to unlock the mystery that has hitherto surrounded our own megalithic monuments. We find traces of this serpent-worship in all parts of the world whither the Turanian races have migrated. In Egypt the testimony of the hieroglyphics carved upon the megalithic monuments proves that this form of worship prevailed among that people. In Grecian mythology, we find abundant traces of it as instanced in the legends of the infant Hercules strangling the serpent, also in the worship of Esculapius in the form of a serpent in the grove at Epidaurus, and again in the myths of Cecrops, Jason,

Cadmus and Theseus. As an instance of serpent-worship in Roman mythology, I need only instance the *caduceus* of Mercury, which consisted of a rod entwined by two serpents. Under the Empire this form of worship became so popular that the number of tame serpents was a positive nuisance. In Scandinavia, the same form of worship prevailed, whence it reached our own island; and probably the legend of St. Patrick driving the serpents out of Ireland is a proof that ophio-latrelia existed there. In Africa it is said that the characteristics of this form of worship at the present day are continued in full vigour and perfection.

It has been thought that serpent-worship was connected with that of the Sun, and of this there is every show of probability. Serpents biting their tails or interwoven in rings have in all ages been familiar to astrologers as symbols of vast astronomical cycles, and of the signs of the Zodiac. This also would account for the circular form of the temples in which this peculiar mode of worship is known to have been practised. The hierogram of the Sun was a circle, and consequently the temples were circular: in accordance with the impulses of a similar instinct the Arkites who adored the personified ark of Noah built their temples in the form of a ship; whilst to come down to our own times and feelings, the Christian retains a remnant of the same idea when he builds his Church in the form of a cross, that being at once the symbol of his creed, and the hierogram of his Deity.

Let us now see how this bears on the origin and adaptation of the trilithons of Stonehenge. I have mentioned the existence of temples in India undoubtedly dedicated to serpent-worship; now these in so many respects resemble the monument of Stonehenge, that it is impossible to imagine that the coincidence is accidental. The Indian temples are hypæthral or exposed to the sky, as is the case with Stonehenge; whilst the mighty columns are in all instances connected by horizontal imposts, yet in no case does there appear a vestige of any provision for a roof; indeed the stones which form the inner circle are insufficient in height for such a purpose; the size of the area comprised within the limits of the structure would also have precluded any attempt at covering it with a roof. Other points of resemblance between Stonehenge and the Dracontine temples of India may be pointed out. The inner Tope or building of the Eastern megalithic structures is surrounded by a circular screen of monoliths, and what is very remarkable, the screen of the Amravati Tope is in diameter exactly double that of Stonehenge. In

each instance a processional path occurs between the outer screen and the inner building; at Amravati, the stones which form this inner ring are seven feet in height; at Stonehenge, the smaller stones of the inner circle are six feet high. The interior of the Tope was occupied by a number of buildings; this may also have been the case at Stonehenge, the so-called altar-stone alone surviving, whilst all else has been destroyed.

Here then we seem to have a clue to the origin and adaptation of the megalithic circular temples of our own island. They are the surviving memorials of a Turanian people, who in the far distant past were the sole inhabitants of whose existence we have any knowledge: the interesting memorials of their primitive antiquity that they have bequeathed to us prove that they had some knowledge of sculpture and the decorative arts, and that they were possessed of a barbaric love of vast and imposing masses, a taste which found its expression in the evidence of difficulties overcome, and the display of great physical power. These then they raised, and they still remain scattered throughout the land, abundant evidence of the influence and persistency of that peculiar form of worship which was then cultivated—the worship of the serpent—the oldest known form of religious idea.

The inference at which I have arrived appears to be fairly deducible from the evidence brought forward. But whether I am correct in this assumption or not, no one in the present day would refer these wonderful monuments of antient energy and skill to a Druidical origin. The specific idea implied in the popular term of Druids' temples appears to be finally abandoned. After the devotion of a literature to the unravelling of the mysteries of the Druids, the subject is still buried in obscurity; we follow a safer and more definite guide when, by the simple process of substituting comparisons for theory, we trace the peculiar character of these so-called Druidical monuments to the requirements of a faith and a cultus which appear once to have exercised a general influence upon the human race at large.

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The following Table shows the progress and present state of the Association with respect to the number of Members.

	Honorary.	Life.	Annual.	Total.
July 30th, 1868	1	5	172	178
Since elected	..	6	76	82
Since deceased	..	..	1	1
Since withdrawn	..	..	7	7
Since erased	..	..	6	6
July 22nd, 1869	1	11	234	246

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